Resource Management Plan

for
Steelhead, Coho Salmon, Chum Salmon, Sockeye Salmon & Pink Salmon

Puget Sound Treaty Tribes
&
Washington Department
of Fish and Wildlife

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Abbreviations and Acronyms

Abbreviation	Meaning
AD	Adipose fin clip
BIA	Bureau of Indian Affairs
BMP	Best management practices
BRAP	Benefit-Risk Assessment Procedure
CMS	Washington Comprehensive Monitoring Strategy and Action Plan
CWT	Coded-wire tag
DIT	Double index tag
ESA	Endangered Species Act
ESHB	Engrossed Substitute House Bill
ESU	Evolutionarily significant unit
fl	Fork length
fpp	Fish per pound
HGMP	Hatchery and genetic management plan
HSRG	Hatchery Scientific Review Group
IHNV	Infectious Hematopoietic Necrosis Virus
mm	Millimeters
MOC	Monitoring Oversight Committee
NMFS	National Marine Fisheries Service (see also NOAAF)
NOAAF	National Oceanic and Atmospheric Administration Fisheries
NPDES	National Pollution Discharge Elimination Permit
PSE	Puget Sound Energy
PSSMP	Puget Sound Salmon Management Plan
PSTRT	Puget Sound Technical Recovery Team
RMP	Resource management plan
RMP	River mile
SaSI	Salmonid Stock Inventory
SASSI	Salmon and Steelhead Stock Inventory
SCCI	Summer Chum Conservation Initiative
SWIG	Species Interaction Work Group
USFWS	United States Fish and Wildlife Service
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WRIA	Water Resource Inventory Area

SUMMARY

The goal of the Tribes and Washington Department of Fish and Wildlife (WDFW) is to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and their ecosystems to sustain ceremonial, subsistence, commercial and recreational fisheries, non-consumptive fish benefits and other cultural and ecological values. The purpose of this resource management plan (RMP) is to describe the overall role of hatcheries in achieving the co-managers' resource management goals and their consistency with protection given to Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal and Strait of Juan de Fuca summer chum salmon (*O. keta*), and bull trout (*Salvelinus confluentus*) under the Endangered Species Act (ESA). This plan focuses on species of salmon cultured in the Puget Sound that are not currently protected under the Endangered Species Act.

Providing harvest opportunities is an important, legally defined role for hatcheries. Conservation of populations is another important role. Hatchery reform, which is the systematic application of scientific principles to hatcheries, is a key element of using hatcheries to help recover and conserve naturally spawning populations and to support sustainable fisheries. This plan outlines a framework for using adaptive management to implement hatchery reform.

The following general principles guide this plan:

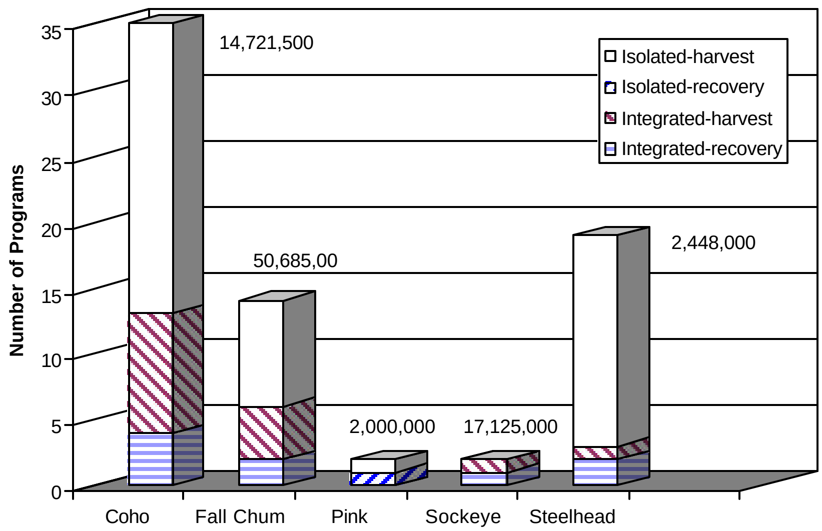
- Hatchery programs need clearly stated goals, performance objectives, and performance indicators
- Hatchery programs need to assess, manage, and reduce risks associated with potential interactions between coho, steelhead, sockeye, chum and pink salmon hatchery programs and natural populations listed under ESA. Brood stock collection, fish health, and rearing and release strategies of non-Chinook species are areas of potential interactions between hatchery programs and protected wild stocks.
- Hatchery program managers need to coordinate with fishery managers to maximize benefits and minimize biological risks so that they do not compromise overall plans to conserve salmon population protected by ESA.
- Hatchery programs will be based on adaptive management, which includes having adequate monitoring and evaluation to determine whether the hatchery program is meeting its objectives. Protocols will be in place for making revisions to the program based on risk evaluations, the best available monitoring and research information, and the adaptive management process.
- Hatchery programs must be consistent with the plans and conditions identified by Federal courts with jurisdiction over tribal harvest allocations
- Hatchery programs will monitor as management intent and wherever practical the "take" of listed salmon occurring as a result of the program and will provide that information as needed.

Implementing these general principles requires an adaptive management framework. The plan describes seven key elements of the adaptive management framework. These include

- An integrated strategy for prioritizing recovery actions across the ESU
- Defined goals and objectives for hatchery programs
- A framework of four artificial production strategies for reaching goals and objectives
- Strategy-specific guidelines for operating hatchery programs
- Scientific tools for evaluating hatchery operations, including statistical analyses, risk-benefit assessments, and independent scientific review

- A decision-making framework for considering in-season, annual, and long-term changes in hatchery objectives and standard operating modes described in HGMPs and for resolving disputes
- Implementation using available resources

The plan covers 72 state and tribal hatchery programs in the Puget Sound for coho salmon (35), steelhead (19), fall chum salmon (14), pink salmon (2), and sockeye salmon (2). Each of these programs uses one of four artificial production strategies to achieve its objectives while minimizing risk to listed species. Nearly 65% of these programs use an isolated-harvest strategy, which is intended to provide fish for harvest while maintaining reproductive and often ecological isolation from natural populations. Although none of the species cultured is listed under the ESA, 14% of these programs are focused on sustaining or rebuilding depleted populations.



Summary Figure 1. Number of programs, total production for each species, and artificial production strategies used for each species covered in this plan.

The plan reviews potential adverse effects of these hatchery programs on listed species generally and also specifically for each program. Potential adverse effects include impacts from hatchery facilities, impacts from brood stock collection, genetic effects, and ecological interactions, such as predation, competition, disease, and nutrient enhancement. It describes key actions and commitments to reduce risk. Key actions to reduce risk include

- Marking and recovering tagged hatchery fish
- Reducing production levels where appropriate
- Managing release timing or locations to minimize opportunity for negative ecological interactions with listed species
- Managing fish sizes at release to minimize predation on listed species
- Regular monitoring and treatment of hatchery fish to minimize risk of disease
- Research on fish movement, distributions, habitat use, and predation after leaving the hatchery, which will provide better information for assessing risk and changing hatchery practices.
- Managing effluent discharges from the hatchery
- Improving hatchery facilities and operations of water intake structures, fish passage, or brood stock collection where it could result in impacts on listed species

INTRODUCTION

The goal of the Tribes and Washington Department of Fish and Wldlife (WDFW) is to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and their ecosystems to sustain ceremonial, subsistence, commercial and recreational fisheries, non-consumptive fish benefits and other cultural and ecological values. Protecting and restoring of the productivity, abundance and diversity of salmon depends on successful management of all factors affecting salmon life history, including freshwater, estuarine and marine habitats, ecological interactions, harvest, and hatchery programs.

Purpose

The purpose of this resource management plan (RMP) is to describe the overall role of hatcheries in achieving the co-managers' resource management goals and their consistency with protection given to Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal and Strait of Juan de Fuca summer chum salmon (*O. keta*), and bull trout (*Salvelinus confluentus*) under the Endangered Species Act (ESA). The plan focuses on species of salmon cultured in the Puget Sound that are not currently protected under the ESA. These include coho salmon (*O. kisutch*), steelhead (*O. mykiss*), chum salmon, pink salmon (*O. gorbuscha*), and sockeye salmon (*O. nerka*). Anadromous Dolly Varden (*S. malma*) and cutthroat trout (*O. clarki*) also occur in the Puget Sound but are not widely propagated.

The plan encompasses both tribal and WDFW programs. These programs often operate in the same watersheds (Figure 1), exchange eggs, and share rearing space to maximize effectiveness of the programs. Benefits of the programs are also shared, including conservation of critically depressed populations and harvest of healthy populations. Hatchery and genetic management plans (HGMPs) provide detailed descriptions of each program.

Providing harvest opportunities is an important, legally definedrole for hatcheries. In the *United States* v. *Washington* the court concluded:

> "The hatchery programs have served a mitigating function since their inception in 1895. 506 Supp. at 198. They are designed essentially to replace natural fish lost to non-Indian degradation of the habitat and commercialization of the fishing industry. Id. Under these circumstances, it is only just to consider such replacement fish as subject to allocation. For the tribes to bear the full burden of the decline caused by the non-Indian neighbors without sharing the replacement achieved through the hatcheries, would be an inequity and inconsistent with the Treaty." *United States v. Washington*, 759 f.2d 1353m 1360 (9th Cir)(en banc), cert. Denied, 474 U.S. 994 (1985).

The court-ordered Puget Sound Salmon Management Plan (PSSMP) provides the framework for coordinating these programs, treaty fishing rights, artificial production objectives, and artificial production levels.

Hatchery reform is an important part of the co-managers' hatchery programs. Hatchery reform is the systematic application of scientific principles to hatcheries to help recover and conserve naturally spawning populations and to support sustainable fisheries. WDFW has a long history of making scientific improvements in salmon culture. Through co-management, the tribes and WDFW have been actively engaged in hatchery reform. This plan describes the key components of an adaptive management frame for using the best available scientific information and evaluations to implement changes in hatchery programs. The Puget Sound Salmon Management Plan provides the legal foundation for implementing these changes.

Based on this framework, the parties to *United States v. Washington*, with the NOAA Fisheries (NOAAF), jointly developed this plan. It builds on the biological assessment of tribal hatchery programs for Chinook salmon submitted to NMFS by the Bureau of Indian Affairs (BIA) in October 1999, as required by section 7 of the ESA, and management alternatives subsequently developed by NMFS and the tribes; the resource management plan developed for Chinook salmon under the Comprehensive Chinook Salmon Management Plan, and the review and recommendations of the Hatchery Scientific Review Group (HSRG), a panel of independent scientists charged by the U.S Congress with ensuring hatchery reform.

General Principles

The following general principles guide this plan:

- Hatchery programs need clearly stated goals, performance objectives, and performance indicators
- Hatchery programs need to assess, manage, and reduce risks associated with potential interactions between coho, steelhead, sockeye, chum and pink salmon hatchery programs and natural populations listed under ESA. Brood stock collection, fish health, and rearing and release strategies of non-Chinook species are areas of potential interactions between hatchery programs and protected wild stocks.
- Hatchery program managers need to coordinate with fishery managers to maximize benefits and minimize biological risks so that they do not compromise overall plans to conserve salmon population protected by ESA.
- Hatchery programs will be based on adaptive management, which includes having adequate monitoring and evaluation to determine whether the hatchery program is meeting its objectives. Protocols will be in place for making revisions to the program based on risk evaluations, the best available monitoring and research information, and the adaptive management process.
- Hatchery programs must be consistent with the plans and conditions identified by Federal courts with jurisdiction over tribal harvest allocations
- Hatchery programs will monitor as management intent and wherever practical the "take" of listed salmon occurring as a result of the program and will provide that information as needed.

Hatchery Reform and Adaptive Management

Hatchery reform is the ongoing, systematic application of scientific principles to improve hatcheries for recovering and conserving naturally spawning populations and supporting sustainable fisheries (Hatchery Scientific Review Group 2000). A key component of this is adaptive management. Adaptive management is a management process that incorporates research, monitoring, and scientific evaluation to allow managers to make good decisions while operating in the face of uncertainty about future circumstances and consequences (Holling 1978, Walters 1986).

Adaptive management is often associated with large-scale experiments (i.e. active adaptive management), where the best decision can be made only when the outcome of the experiments is known. Adaptive management also includes other strategies, however, such as passive adaptive management and evolutionary problem solving (Anderson et al. 2003), which are better suited to hatcheries. Passive adaptive management uses the best available scientific information to make decisions initially but also specifies multiple, future decision points where new information is analyzed and incorporated into decisions and the best apparent decision is chosen at each point. Evolutionary problem solving encourages managers to experiment with innovations independently and share results. Change depends largely on encouraging communication. Evolutionary problem solving is most useful when programs have multiple, incommensurable goals (Anderson et al. 2003).

The co-managers' adaptive management framework combines passive adaptive management and evolutionary problem solving. It has seven key elements:

- An integrated strategy for the ESU
- Defined goals and objectives for hatchery programs
- A framework of artificial production strategies for reaching goals and objectives
- Strategy-specific guidelines for operating hatchery programs
- Scientific tools for evaluating hatchery operations, including statistical analyses, risk-benefit assessments, and independent scientific review
- A decision-making framework for considering in-season, annual, and long-term changes in hatchery objectives and standard operating modes described in HGMPs and resolving disputes
- Implementation using available resources

Overall Strategy for the ESU

The overall strategy for managing hatcheries at the ESU scale recognizes that risk of extinction to an ESU, potential recovery of habitat to sustain natural populations, and harvest needs are different in different watersheds of the Puget Sound.

Overall Strategy for Threatened Salmon

1. Protect and recover indigenous populations of salmon in watersheds where they still occur (Recovery Category 1 watersheds).

2. Implement management actions that use the most locally adapted stock to reestablish and sustain natural production in watersheds that no longer have indigenous populations, but where natural production is possible given existence of suitable or productive habitat (Recovery Category 2 watersheds).

3. Manage watersheds that historically may have not supported self-sustaining, naturally spawning populations for hatchery production, when desired, while maintaining habitat for other species that are supported by these watersheds (Recovery Category 3 watersheds).

4. Protect treaty rights by providing fish for harvest.

Historically, WDFW and the tribes have managed hatcheries according to their impacts on salmon within a watershed or fishery. Because Puget Sound salmon also interact over much larger geographic and evolutionary scales, recovery of the ESU also calls for strategies that address opportunities across the whole region.

The opportunities vary. The Puget Sound includes areas where the habitat can still support sustainable natural production, areas where habitat for natural production has been irrevocably lost, and areas where some species of salmon were never self-sustaining, independent populations. In addition, the Puget Sound contains areas where indigenous local stocks persist and areas where local stocks are a composite of indigenous stocks and introduced hatchery strains. Extensive genetic analyses of spawning aggregations throughout the Puget Sound show naturally-spawning aggregations in many river basins that are genetically different despite a history of inter-basin transfers. In some areas where natural production has been lost, hatchery production is used to mitigate for lost natural production and to protect tribal treaty rights. Consequently, in a few major river systems that historically contained indigenous populations of salmon, natural production is derived from hatchery fish or admixtures of native and introduced populations. In addition, salmon sometimes spawn in smaller, independent watersheds, which historically did not contain independent sustainable populations. In many cases, current spawning in these watersheds comes from hatchery fish released from nearby facilities. In other areas, mitigation hatcheries can be located in areas where the returning adults tend to be geographically isolated from naturally-spawning aggregations.

Goals and Objectives

Clearly defined goals are a key element of a passive adaptive management process. The co-managers' overall goal begins the Introduction to this plan (above). The co-managers describe specific goals and objectives for hatchery programs in HGMPs. These goals address legal obligations and social benefits of hatcheries as well as their role in conserving natural populations. Defining the relationships between multiple, incommensurable goals is important for developing an evolutionary problem solving strategy in adaptive management.

Artificial Production Strategies

Hatcheries meet a variety of needs from providing fish for harvest to preventing extinction. Production strategies to meet these needs carry different benefits and risks. Because hatchery reform is based on balancing benefits from hatcheries with risks to natural populations, different strategies are necessary for different hatcheries.

This plan recognizes four basic strategies, based on the intended benefits of hatcheries and whether the hatchery fish are intended to spawn in the wild with naturally produced fish (Table 1). The two main benefits of hatcheries are **harvest** or **recovery of natural populations**. The two main reproductive strategies that determine the degree of interaction with natural populations are **integrated production** strategies or **isolated production** strategies. Integrated projects intend that artificially propagated fish spawn in the wild and become fully reproductively integrated as a single population. Isolated programs are designed to keep artificially propagated fish from spawning in the wild or to prevent genetic interactions with natural populations. HGMPs identify the strategy of each program.

Table 1. Artificial production strategies and their primary uses.

Primary Management Objective	Demographic relationship to natural population(s) in watershed: Integrated Production	Isolated Production
Recovery	• Prevent extinction • Increase natural origin recruits using the local stock • Reintroduction • Research	• Prevent extinction • Create 'reserve' population in case other recovery options fail • Gene banking until reintroduction • Research
Harvest	• When isolated approach is not feasible • Maintaining local stocks • During rebuilding • Mitigation • Research	• Create new or enhance existing fishing opportunities • Mitigation • Allocation • Research

Ultimately, the potential success of these strategies in any given program is unknown and depends on both innovation and communication (evolutionary problem solving) and implementing monitoring, evaluation, and decision-making at key points in future (passive adaptive management).

Guidelines

Guidelines describe the desired operating conditions for programs. General guidelines describing the four basic artificial production strategies are in Appendix A. HGMPs describe in more detail the current operating procedures and guidelines adopted for each hatchery program. Current guidelines and operating procedures reflect the unique historical, legal, and logistical circumstances of each program and the opportunities for improvement. This plan specifically recognizes that current guidelines and operating procedures will change as a result of the adaptive management process the co-managers use to implement hatchery reform.

Scientific Evaluation

Tools for evaluating hatchery programs include monitoring, research, and risk assessments.

Monitoring and Research

Monitoring and research provide new information for evaluating hatchery programs under the passive adaptive management strategy. The tribes and WDFW monitor fish culture at all state and tribal facilities. With increasing scientific and policy interest on monitoring for salmon recovery (Washington Independent Science Panel 2000), the co-managers have developed more comprehensive frameworks for understanding direct and indirect effects of hatcheries through implementation, effectiveness, and validation monitoring. The Washington State Legislature directed that the State develop a comprehensive strategy and action plan for measuring success in recovering salmon, including the effects of hatcheries, in Substitute Senate Bill 5637. As a result, the Washington Comprehensive Monitoring Strategy and Action Plan forWatershed Health and Salmon Recovery (CMS) outlined a monitoring framework focused on implementation monitoring of compliance with established best management practices (BMPs) for hatcheries and effectiveness monitoring of BMPs in reducing or eliminating adverse effects of hatchery fish on wild salmon (Monitoring Oversight Committee 2002). The CMS did not identify specific BMPs, which will need to be developed and agreed to by state and tribal the co-managers. Interim guidelines for operating hatcheries under different artificial production strategies, however, are in Appendix A. Additional guidelines are available from the Hatchery Scientific Review Group (HSRG 2002a).

Although the state and tribes conduct research on hatchery practices, lack of available money limits implementation of comprehensive hatchery monitoring. The Monitoring Oversight Committee (MOC) for the CMS—which was made up of policy representatives from state agencies, NOAA Fisheries, U.S. Fish and Wildlife Service, other federal agencies, and the tribes—recognized that monitoring all desired hatchery criteria was impossible, given the available resources for all salmon recovery activities. They determined that monitoring associated with hatcheries was a medium-level priority compared to other salmon recovery monitoring activities. Of the possible criteria for monitoring in hatcheries (e.g. HSRG 2002b), they prioritized monitoring that focused on 1) marking and sampling hatchery fish, 2) developing genetic baselines of hatchery and wild populations, 3) selecting hatchery brood stock, 4) disease control, 5) fish screening and passage, and 6) hatchery pollution abatement (Monitoring Oversight Committee 2002). Summaries of monitoring activities for these are in Appendix B.

Research helps explain trends in monitoring, provides information for developing better risk assessments, and tests new ideas for improving hatcheries. Although funding for research is also limited, scientists from the tribes and WDFW are actively working with NOAA Fisheries and the HSRG to identify and conduct critical research in the Puget Sound region that will help indicate the genetic, ecological, and demographic effects of salmon artificial propagation programs on the survival and productivity of listed and non-listed salmonid populations. Summaries of recent research are in Appendix C.

Risk-Benefit Assessments

As co-managers experiment with different ways of adapting hatchery programs to be consistent with operating guidelines and the unique circumstances of the watershed, they will not be able to monitor everything. Under the evolutionary problem solving strategy of adaptive management, models for systematically assessing risks and benefits in an objective, transparent framework at key decision points provide an important way of linking the strategy to passive adaptive management. The co-managers have developed and will continue to refine these models to regularly evaluate their hatchery programs (Currens and Busack, in press). For example, because no comprehensive model for evaluating hatcheries existed, WDFW and the tribes developed the Benefit-Risk Assessment Procedure (BRAP) as a tool to evaluate the risks and benefits of hatchery programs in the ecological context of each watershed. WDFW used BRAP to analyze risks and benefits of hatchery programs systematically for Chinook salmon and identify changes. BRAP has been reviewed by the Hatchery Scientific Review Group, a panel of independent scientists, to ensure that it is scientifically sound and consistent with overall approaches to hatchery reform. Following an additional review by the Independent Science Review Panel of the Northwest Power Planning Council in 2003, Drs. Ken Currens (Northwest Indian Fisheries Commission), Craig Busack and Todd Pearsons (WDFW), and Lars Mobrand (Mobrand Biometrics) received funding to improve the analytical foundation of the tool and develop software to make it easier to use. This will be available by January 2005 (Appendix D).

Analytical tools such as these are important for informing policy decisions. They do not create or dictate policy changes for implementing hatchery reform. Implementation also depends on political, social and legal goals, which are incorporated through co-manager policy review, and having available resources to make the changes to achieve a consistent balance of political and social goals and benefits. The process for policy review, implementation or modification of technical recommendations generating from monitoring and evaluation, risk assessments, or independent scientific review is reached through the legal and policy framework described below.

Independent Scientific Review

Independent scientific review provides a critical role in ensuring that technical recommendations are objective and credible. Independent scientific review may take several forms. Independent review may consist of a group of independent scientists gathering information on hatchery programs, conducting their own assessment, and generating recommendations. Alternatively, independent scientific review may focus on reviewing the scientific merits of the co-managers' own assessment methods, results, and recommendations.

The co-managers currently have at least three major mechanisms for independent scientific review. The Hatchery Scientific Review Group (HSRG) was created by Congress in 2001 to serve as an independent panel working with agencies and tribes to produce guidelines and recommended actions and ensure that the goals of hatchery reform are carried out. During 2001-2003, the HSRG reviewed all hatchery programs in western Washington and developed recommendations for changes in those programs based on dual goals of recovering natural populations and providing for sustainable fisheries.

The Independent Science Panel (ISP) for Washington can also provide independent review of hatchery programs. Created under ESHB 2496 by the Washington State Legislature in 1998, the ISP was charged with providing independent scientific review of the state's salmon recovery and planning efforts, including hatchery programs.

Finally, the co-managers may use ad hoc independent scientific review panels to address specific issues on a case-by-case basis. The key to these kinds of reviews is identifying reviewers with appropriate expertise and willingness to participate. The ISP helps coordinate and organize independent scientific review panels as does the American Fisheries Society.

Decision Making Framework

The Puget Sound Salmon Management Plan (PSSMP) under *U.S.* v *Washington*, provides the legal framework and identifies tools for making changes in hatcheries. These tools include 1) descriptions of standard modes of operating hatchery programs developed under regional planning by the co-managers (equilibrium brood documents and equilibrium brood programs), 2) annual descriptions and review of the operating objectives and changes from the standard program that can be used for annual planning (Future Brood Document and Co-managers' Fish Disease Policy), 3) regional management plans to coordinate co-manager activities and priorities, 4) exchange of technical information and analyses through coordinated information systems, and 5) dispute resolution.

Many of the tools and processes developed under PSSMP are being updated and reinvigorated to meet the needs of hatchery reform and the Endangered Species Act. HGMPs contain much the same information as equilibrium brood documents. The Future Brood Document, which under PSSMP annually describes proposed changes in operating objectives for co-manager review, will be complemented by a new database that tracks implementation of recommended changes to hatchery programs developed from co-manager and independent scientific review. Using both these databases, co-managers will be able to review recommendations and changes to programs.

Implementation occurs with policy review, decisions, and allocation of resources to continue programs or make changes. The co-management process focuses on decisions as they occur at regular points in future in a three-tier process (Table 2), which is consistent with an integrated passive adaptive management and evolutionary problem solving strategy. The most important review and decision-making cycle is every 3-5 years when regular, regional review of hatchery programs and monitoring data may lead to recommendations for changing HGMPs or equilibrium brood documents and programs (Tier 1). Conducting these reviews using a variety of jointly developed analytical models is the responsibility of the co-managers. Independent scientific review is also important to provide new insights and scientific credibility. If co-managers disagree about recommendations, regional technical and policy meetings between the co-managers are used to resolve the differences. If this fails, the issue is identified for discussion at the annual state-tribal co-managers' meeting between the WDFW director and the tribes. The annual co-managers' meeting has been a regular forum for lead policy representatives from state and tribes to identify significant issues that cannot be resolved locally or that affect multiple tribes and to identify the process and schedule for resolving them. The PSSMP describes additional legally recognized dispute resolution measures, should they be necessary, but these have not been used in many years.

Table 2. Three-tiered process of co-management review and decision-making for hatchery reform and adaptive management.

	Time Period	Implementation Document	Evaluation Tool	Dispute Resolution
Tier 1	3-5 years	• Hatchery plans • Equilibrium brood • HGMP	• Monitoring & evaluation • Independent scientific review • Risk assessment	• Regional co-management meetings; • annual state/tribal co-managers' meeting
Tier 2	Annual	• Future Brood Document • Hatchery Reform Recommendations	• Risk assessment • Co-manager review	• Regional co-management meetings; • annual state/tribal co-managers' meeting
Tier 3	Intra-annual	• Fish transfer requests • Co-managers' Fish Disease Policy	• Risk assessment • Co-manager review	• Regional co-management meetings;

Evaluation also occurs annually for individual programs (Tier 2). The Future Brood Document, which describes annual production objectives and program changes, and list of hatchery reform recommendations developed by independent scientific review are the key implementation documents for review. These are compiled annually by WDFW and reviewed by the co-managers. Risk assessment modeling provides a tool for analyzing the changes, should it be necessary. If co-managers disagree about proposed actions, technical and policy meetings between the co-managers in the region are needed to resolve the differences. If this fails, the issue is identified for discussion at the annual state-tribal co-managers' meeting between the WDFW director and the tribes.

Finally, the co-managers also evaluate intra-annual changes from the Future Brood Document (upper tier, Figure 3). By their nature, these changes involve transfers of fish (adults, gametes, or juveniles for growing and release) between watersheds that would not be permitted under the Co-managers' Fish Disease Policy and other fish transfer guidelines. Failure of the co-managers at the regional level to agree to the fish transfer may lead to dispute resolution or ultimately to the transfer not occurring.

Implementation

Implementation of hatchery reform focuses on improving practices and facilities that lead to better management reliability and greater resilience of natural and hatchery populations (Currens and Busack 1995). For most hatchery programs, this involves four major areas: knowledge of natural variability, guidelines, technician performance, and logistics (Currens and Busack 1995, in press; see also “Key Actions to Reduce Risk” in this document). As successes and failures become evident through the adaptive management process described above, appropriate responses will require integrated responses by stock assessment biologists, fishery managers, habitat managers, and hatchery managers across the major management areas (Table 3). Changes in harvest rates or population status, which are generally evaluated by stock assessment biologists and fishery managers, may require changes in hatchery production levels, changes in marking of hatchery fish, or even changes in the objective (and consequently operating guidelines) for the program.

Table 3. Adaptive management responses.

Management Areas	Integrated Response	Hatchery Management Response
Knowledge of natural variability	• Monitor population status and tends • Collect and maintain baseline environmental, habitat, population, and fishery data	• Mark appropriate numbers of hatchery fish • Recover marked fish returning to hatchery • Maintain genetic baseline on brood stocks • Monitor brood stock characteristics • Monitor fish performance in hatchery
Guidelines	• Evaluate conservation guidelines • Evaluate operating guidelines	• Change marking and tag recovery practices • Change brood stock selection criteria • Change in production goals • Change brood stock collection practices • Change mating practices • Change rearing practices • Change transportation and release practices
Technician Performance	• Education and training • Performance evaluations	• Develop education and training for hatchery managers and technicians • Maintain performance evaluations
Logistics	• Improve facilities and equipment • Improve coordination	• Improve marking and tag recovery equipment and facilities • Improve brood stock collection facilities • Improve mating facilities • Improve rearing facilities • Improve transportation equipment and release facilities • Improve program coordination and data sharing

History of Artificial Propagation in the Puget Sound

Salmon have been propagated in hatcheries within the Puget Sound region since before 1900. Since that time, the objectives for hatcheries have changed. The earliest purpose for hatcheries was to produce large numbers of fish for harvest. As salmon habitat was altered or destroyed by dams, forestry, and urbanization, mitigation for lost natural production and fishing opportunity became a major purpose for hatchery production. Over the last 20 years, the purposes for hatcheries have evolved to include rebuilding wild populations, preserving unique genetic races, and reintroducing fish to areas where they have been extirpated.

Improvements in Hatchery Technology Increase Production

Chinook salmon

Constant improvements in husbandry and hatchery technology over the last century have made Washington hatcheries one of the largest producers of salmon in North America. The earliest hatcheries in Puget Sound were not originally built to propagate Chinook salmon, but hatchery managers adjusted operations to focus on production of that species. By 1903, however, eight state and two federal hatcheries were producing Chinook salmon (WDFG, 1904). Major improvements followed with development of strategies for producing Chinook salmon based on releasing them at different life stages as fry, fingerlings, subyearlings, or yearlings (Fig. 1).

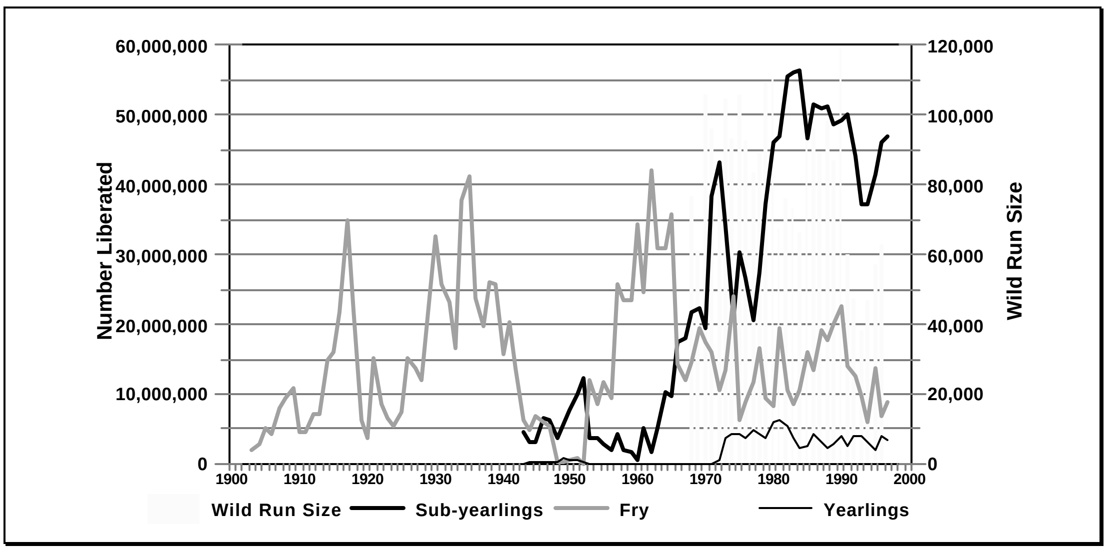


Figure 1. Total releases of Chinook salmon by age class and estimated wild run size in the Puget Sound.

From the late 1890s through 1905, the predominant strategy to enhance salmon abundance was based on collecting large numbers of eggs and releasing fry with very limited or no rearing (WDF, 1958; Becker, 1967). As early as 1902, research indicated that post-release survival would increase by releasing fed fry and fingerlings (WDFG, 1903). Between 1906-1936, hatcheries used large-scale egg-taking and short term rearing of fish to release larger, more viable hatchery Chinook salmon and also unfed fry (WDF, 1958; Becker, 1967).

Beginning in 1937, hatchery technology improved with intensive rearing of fish in ponds. By 1939, results of feeding studies had indicated the economic necessity of rearing salmon at least a few months in freshwater (WDF, 1939). This change resulted in overall decreases in releases of unfed fry, and the better survivals let hatchery managers reduce the volumes of eggs collected (Becker, 1967). By 1942, over half of the total eggs taken in Washington were hatched and reared two months or more prior to release (WDF, 1942), and by 1943, 42% of the Chinook salmon reared in Puget Sound region hatcheries were being released as fingerling or yearling smolts.

Continued expansion and modernization of the hatchery system, advances in nutrition, fish health, fish cultural technology, and greater scientific understanding of the benefits of releasing larger fish led to the production of many millions of fingerlings, subyearling smolts, and yearling smolts each year (Figure 1).

Coho salmon

<u>WDFW Coho Salmon Production</u>
Good information is available on coho salmon releases from the early 1950s through the present. The release numbers, for all sizes, are illustrated in Figure 2. Early release numbers (1950s through 60s) ranged from about 4 to 20 million. Beginning in the 1970s, coho hatchery programs expanded, culminating in 1981 with a total Puget Sound release of over 53 million juveniles. A large portion of these consisted of fry plants of about 1000 to 1400 fpp (34mm-30mm fl). These fish were often released off-station within various tributaries, or as on-station releases as pond space became limited as the fish grew. Cross-basin transfers and back-filling hatchery shortfalls were also a common practice.

Beginning in the mid-1980s, production exhibited a gradual reduction, largely due to the emphasis on releasing the larger smolt-type fish, which range in size from about 20 to 10 fpp (129mm – 163mm fl). The present release goal is approximately 7.1 million coho, released almost entirely as on-station yearling fish. Off-station fingerling releases are now limited to two sites: Green River, where 350,000 fish are out-planted annually from Soos Creek Hatchery, and from Glenwood Springs on Orcas Island, where 10,000 fingerling are released into several island streams. Cross basin transfers are no longer conducted with the exception of those fish that are moved from hatcheries to marine net pen site for final rearing and release.

Production goals are almost entirely focused on producing fish for harvest. The Snow Creek coho program is the only one dedicated towards restoring a natural self-sustaining population.

Recent coho program changes, since 1995, include the following:

- Kendall Creek (Nooksack): 2.0 million fry plant has been eliminated, leaving the current program of 300,000 yearlings
- Glenwood Spring (Orcas Island): production has increased from 20,000 to 110,000 (100,000 as yearlings and 10,000 as fingerlings)
- Issaquah Creek (Lake Washington): 1.0 million fed fry are no longer being produced and planted into Lake Washington streams, leaving the 450,000 yearling program
- Voights Creek (Puyallup): Production program has been reduced from 1.18 million to 780,000
- Minter Creek: production has been reduced from 1.5 million to 1.044 million.

- South Sound Net Pens: program has been reduced from 2.2 million to the present level of 1.8 million.
- Dungeness: program has been reduced from 800,000 to 500,000;
- Squalicum Harbor Net Pen: program has been reduced from 175,000 to 5,000 yearlings.

Tribal Coho Salmon Production

Tribal hatchery facilities began producing coho salmon in the mid-1970s and by 1986 had reached a level of approximately 8.9 million fish per year. Annual production has remained at about that level since that time, but it has comprised an increasingly large percentage of the total WDFW and tribal releases. By 2000, tribal production of coho salmon comprised more than 50% of the total WDFW and tribal releases in the Puget Sound area. Most of the current 12 programs have a goal of harvest augmentation. Two (Stillaguamish River and Puyallup River) are recovery programs with a goal of increasing the abundance of natural stocks.

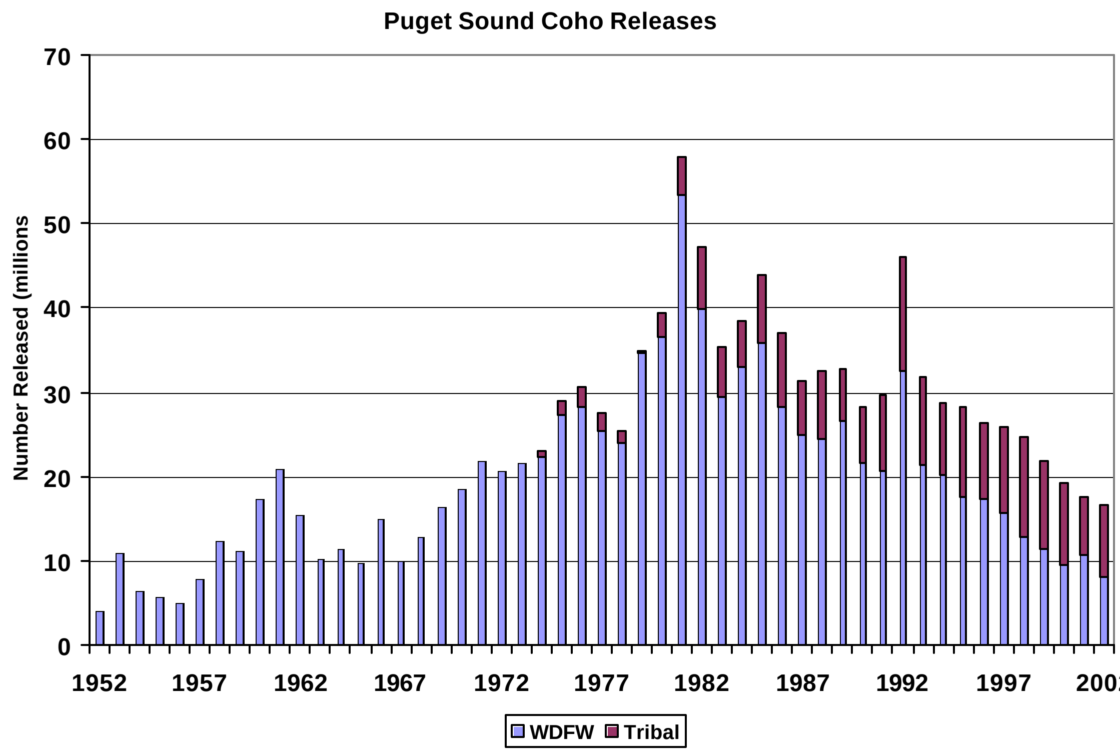


Figure 2. Total annual releases of coho salmon in the Puget Sound.

Steelhead

WDFW Steelhead Production

Steelhead hatchery releases have occurred in Puget Sound since the early 1900s. In 1903 approximately 4.3 million steelhead were released, being produced from the Dungeness, White River, Snohomish and Nisqually hatcheries. By the 1930s steelhead eggs were taken from local returning fish, which were then incubated, reared and released from various hatcheries. The first releases were of fry. By 1936, however, studies showed that better survival was obtained from hatchery fish if they were released as fingerlings, which ranged from 400 to 50 fish per pound.. Even at this size, it was observed that there was little or no returns back to the planting site, and there was little effect on the run sizes that they were assumed to enhance.

In 1945, a new program was started with a stock originating from Chambers Creek. The fish were reared at the South Tacoma Hatchery, which possessed warmer water as compared to other facilities. This provided faster growth, allowing earlier releases. This stock was also transported to coastal and Columbia River systems, but it was not successful outside of Puget Sound, perhaps because it was not adapted to the different environments. By the mid-1970s there was also concern that the successful Chambers Creek hatchery program may be undermining the genetic characteristics of wild populations in the Puget Sound. In response, the Department of Game began taking eggs, rearing and replanting smolts into the river of origin where ever it was feasible.

The Skamania stock is a summer-returning steelhead. This stock was developed in the 1950s from steelhead returning to the Washougal River and reared at the Skamania Hatchery. This stock was used primarily within the Columbia basin, but the Skamania stock was also transferred into Puget Sound, where they have been released in various watersheds.

Today, winter steelhead releases in Puget Sound are predominately of Chambers stock origin Releases occur throughout Puget Sound within the major watersheds including Nooksack, Skagit, Stillaguamish, Snohomish, Green, Puyallup, Deschutes, and Dungeness rivers. The summer-returning Skamania stock releases are limited to the Snohomish, Stillaguamish, and Green rivers.

Steelhead are now released primarily as smolts, ranging in size from about 8 to 5 fpp(179-208 mm fork length). Annual release goal for all Puget Sound facilities is approximately 2.1 million steelhead (winters and summers). This release level is within the range of release numbers since the 1980s (Fig. 3). Prior to the 1980's total annual release numbers are not generally readily available.

Tribal Steelhead Production

Tribal hatchery facilities began producing steelhead in the mid-1970s and by 1993 production had reached a level of 0.5 million fish per year. Releases averaged 0.35 million fish per year during the 1990s, but dropped to approximately 0.2 million by 2002. Currently,only two tribal programs are operating – a harvest augmentation program on the Elwha River and a recovery program on the Green River.

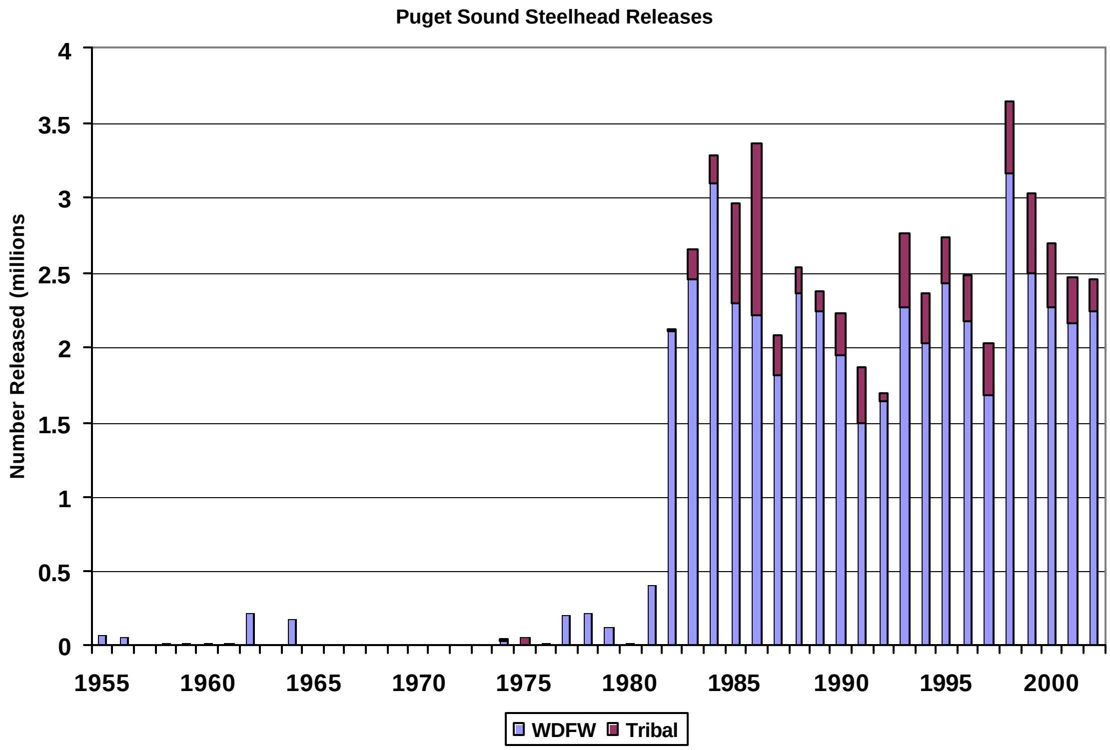


Figure 3. Total annual releases of steelhead in the Puget Sound.

Chum salmon

WDFW Chum Salmon Production
Chum salmon have been reared and released throughout the last century, primarily to enhance commercial fishing opportunities in local areas. Run-timing differences of the various stocks have been used in attempt to provide a greater duration for harvest opportunities. For example, the Walcott chum in Hood Canal, which generally has an earlier return timing, has been transferred to several areas within Puget Sound to enhance fishing opportunities in October and November, as compared to the normal run timing of late November through December.

Production of chum salmon during the 1950s through the early 1970s was maintained at relatively low levels of about one to four million total Puget Sound releases per year with most fish going out as unfed fry of 1000 to 1400 fpp (34mm - 30mm fl). It wasn't until the mid-1970s that chum production grew to a larger scale, jumping to nearly 90 million in 1985 (Fig. 4). Most of the releases occurred in Hood Canal, South Sound and the Nooksack-Samish regions. Since then production has dropped to less than half of the 1985 level, with current production at 32 million, with all of it as fed fry (300 to 400 fpp). Fall chum production is now limited to two regions: Hood Canal, where the majority of production takes place (30 million), and Whatcom Creek in north Puget Sound.

Not represented in the above information is summer chum salmon production in Hood Canal. Unlike fall chum salmon production, which has the main objective of harvest augmentation, the summer chum salmon objective is to restore sustainable populations of summer chum salmon within various Hood Canal streams (Summer Chum Salmon Conservation Initiative 2000).

<u>Tribal Chum Salmon Production</u>
Tribal hatchery facilities began producing fall chum salmon in the mid-1970s with total releases reaching 21.5 million fish by 1985. Production continued to exceed 20 million fish annually through 1989 before declining to an average of approximately 10.5 million in the period from 2000 through 2002 (24% of total WDFW and tribal production). Of the current 10 programs, 8 have a goal of harvest augmentation and 2 have a goal of recovery of wild stocks (Elwha River and Cowling Creek).

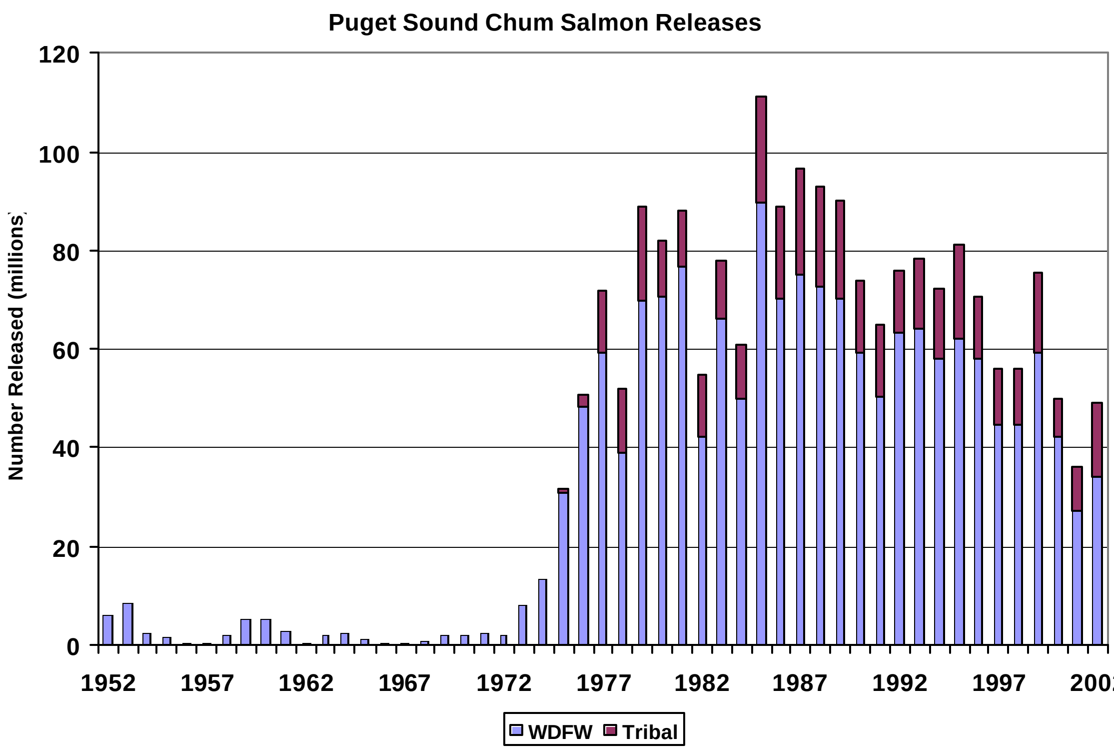


Figure 4. Total annual releases of chum salmon in the Puget Sound.

Pink Salmon

<u>WDFW Pink Salmon Production</u>
Artificial production of pink salmon has played a minor role in the overall development of salmonid hatcheries in the Puget Sound. Early releases occurred in Finch Creek and Dosewallips River (Hood Canal), as well as in South Puget Sound (Minter Creek). Some releases also occurred in the Stillaguamish River. Annual releases throughout the 1950s and 1960s were restricted to less than two million. In 1980 they peaked at nearly 12 million, with subsequent release levels ranging from two to six million (Fig. 5). Currently, pink salmon are released from only two sites. The Hoodsport

Hatchery (Finch Creek) program has a one million release goal with the objective of providing additional harvest opportunity. The Whatcom Creek program in Bellingham Bay has a one million annual release level with an objective of producing an egg source to restore a depleted sub-stock of pink salmon within some local watersheds.

Fish are normally released as fed fry, at about 400 fpp (52mm fl). However, some are released early to provide more pond space.

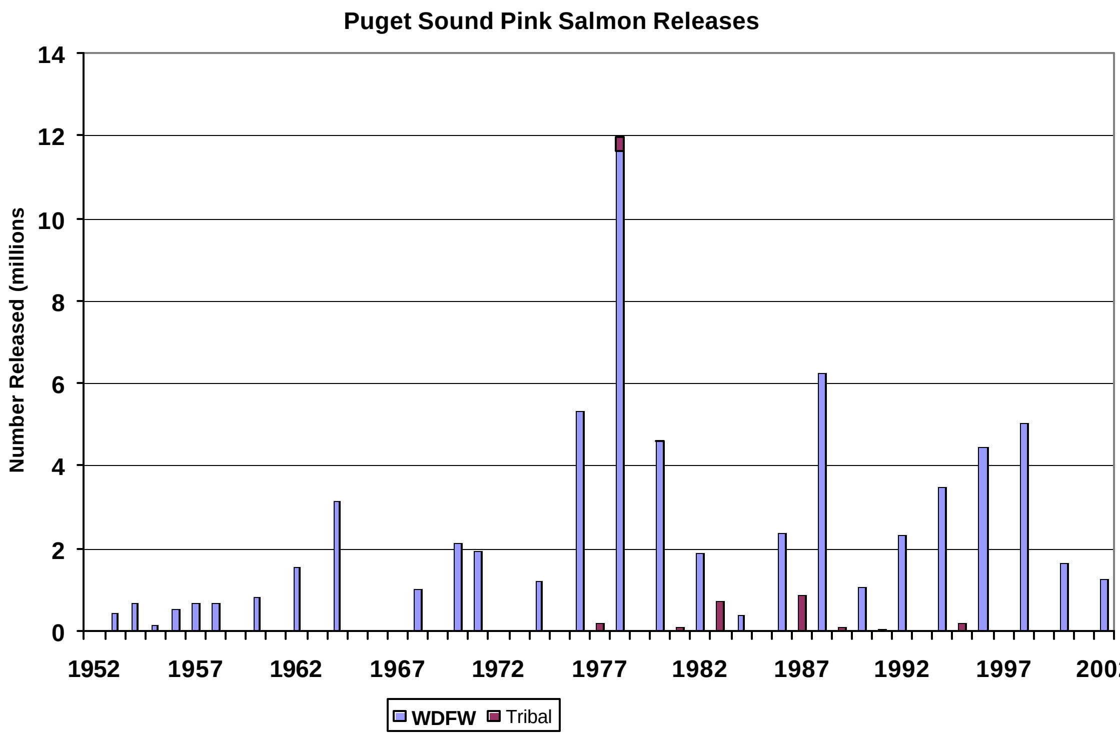


Figure 5. Total annual releases of pink salmon in the Puget Sound.

<u>Tribal Pink Salmon Production</u>
Tribal facilities in Puget Sound have produced limited numbers of pink salmon and no programs are currently operating.

Sockeye salmon

<u>WDFW Sockeye Salmon Production</u>
Releases of sockeye in the early years were small in number and infrequent. Most occurred within the Lake Washington and Sammamish watersheds, such as Issaquah Creek, Rock Creek, Thornton Creek and the Cedar River. A pulse of larger releases occurred in the late 1970s and early 1980s,

with annual totals as high as 10 million fry (Fig. 6). Beginning in the 1990's, as measures to restore Baker Lake sockeye and to enhance Lake Washington sockeye, active and consistent releases were made. The present sockeye operations consists of two programs: Baker Lake with an annual release average of 1.50 million fry and Cedar River, where the annual release goal is 16 million. Fish are released in the fry stage at 2000 to 3000 fpp (approximately 23 mm fl).

Tribal Sockeye Salmon Production

No tribal facilities in Puget Sound have operated sockeye programs.

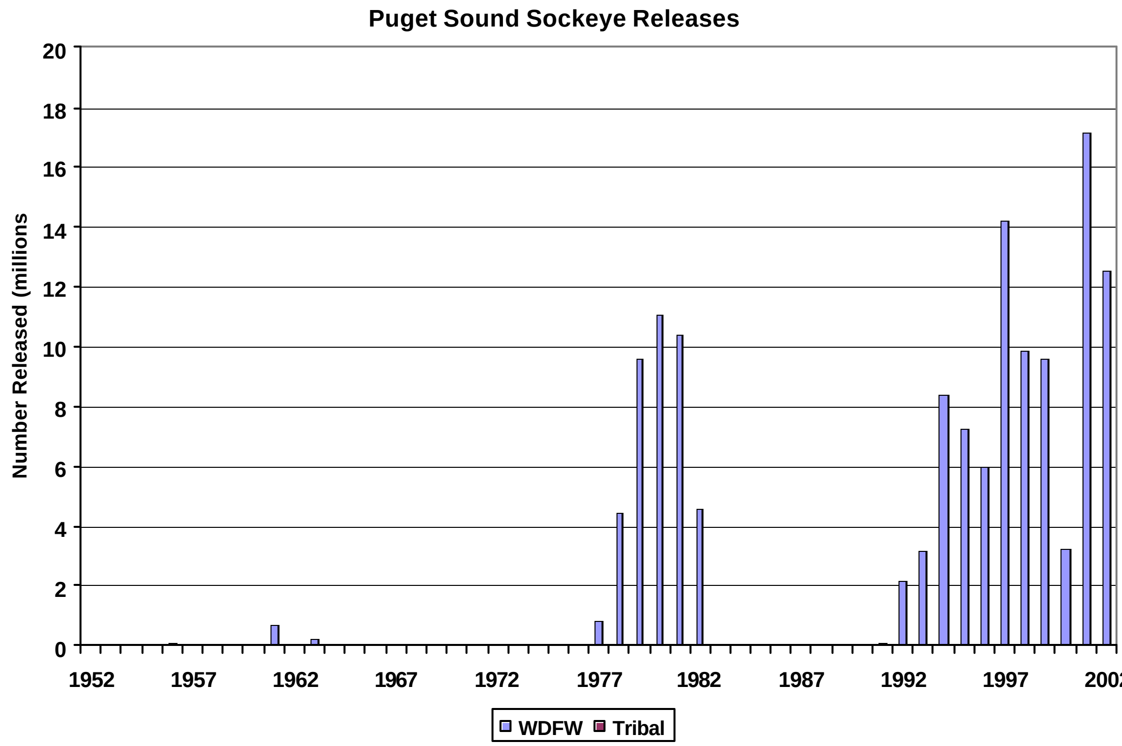


Figure 6. Total annual releases of sockeye salmon in the Puget Sound.

Impacts of the Boldt Decisions

In the 1970s, two Federal court decisions on treaty rights, commonly known as the Boldt decisions, became the legal framework for defining fish production objectives in Washington. *United States v. Washington* affects hatchery production in the Puget Sound and coastal Washington, whereas the *United States v. Oregon* affects hatchery production in the Columbia River. Affirmation of treaty Indian fishing rights and tribal standing as co-managers of the salmonid resource led to more definitive and restrictive management guidelines for hatchery production. Many tribes began building their own hatcheries to provide opportunity to fish where they had not been able to for many years. This placed greater emphasis on producing salmon for harvest in specific, traditional tribal marine and freshwater fishing areas and led to refinement of many hatchery practices, including the selection and transfer of appropriate brood stocks for hatchery programs. Annual planning evolved around the assembly of the Future Brood Document, in which annual production plans are proposed and reviewed by the co-managers. In some areas, court-ordered production plans set precise levels of production by species that will occur each year.

During this period, changes in two different fishery management paradigms converged to foster greater emphasis on developing self-sustaining local brood stocks and maintaining genetic diversity. The legal framework of *United States v. Washington*, which elevated the role of Indian tribes from different watersheds in fishery management, meant that fishery managers needed more precise river-specific hatchery management. During the same period, the stock-concept—a management philosophy that emphasized the local adaptation of salmon returning to different natal streams—also became important. These led to formation and adoption of several important production guidelines and policies. In the early 1980s, WDFW developed genetic guidelines for fish transfers and spawning operations (Hershberger and Iwamota, 1981). WDFW and the tribes also developed and implemented the Co-Manager's Salmonid Disease Control Policy (NWIFC and WDFW 1998), which limited the exchange of fish among watersheds to help prevent the spread of fish pathogens.

Hatcheries for Conservation

In the late 1970s, the decline of several important wild stocks of spring and summer Chinook salmon due to habitat deterioration led co-managers to begin using hatcheries to prevent extinctions. In the White River, for example, annual returns of 5,000 spring Chinook salmon had declined into the teens. In 1977, WDFW began an intensive captive brood stock and gene banking hatchery program to maintain these fish before they became extinct. Programs for other populations soon followed for Chinook salmon in the Nooksack, Elwha, Stillaguamish and Dungeness Rivers. Currently, approximately one-third of Chinook hatchery programs statewide focus on maintaining and rebuilding wild salmon runs.

By the early 1990s, concern for natural populations became critical. Downturns in productivity resulting from back-to-back El Niño events in the ocean and high harvest rates produced fewer and fewer fish to the spawning grounds. Restrictions in harvest failed to improve the condition of depleted wild salmon stocks. At the same time, genetic research had documented the existence of unique, indigenous populations in some watersheds and suggested that transfers of non-indigenous hatchery fish had eliminated indigenous populations in other regions.

These concerns led to new initiatives emphasizing wild salmon and a role for hatcheries in conserving stocks that were threatened. In 1991, WDF revised its stock transfer guidelines (WDF, 1991). During the same period, WDFW and some Puget Sound tribes initiated the Wild Stock Restoration Initiative (WSRI). In 1993, WDFW and the tribes completed the first step of the WSRI—the Salmon and Steelhead Stock Inventory (SASSI, 1992)—a comprehensive inventory of salmon stocks and their status. This became a baseline to identify those salmon populations in immediate or future need of rebuilding. After SASSI, WDFW and the tribes began developing a Wild Salmon Policy that would serve as a framework for managing wild salmonids and their habitats. This policy was completed in 1998. Other regulations and policies implemented by the co-managers in the early 1990s included the National Pollution Discharge Elimination Systems (NPDES) permit requirements, assembly of Hatcheries Operations Plans and Performance Summaries, which detail operational practices employed at each WDFW hatchery to produce healthy hatchery salmon populations and define actions taken at each to minimize effects on wild salmonids (Fuss and Ashbrook, 1995).

Summary of Institutional and Operational Changes

The history of hatcheries shows that managers have adapted hatcheries to meet different priorities and to keep pace with the must current scientific understanding of resource management needs. These have led to different institutional and operational changes that are still continuing.

Institutional Changes

- 1970s–Spawning escapement objectives for natural spawning salmon developed.
- 1970s—Implementation of the Coded Wire Tagging program
- 1974—*United States v Washington*
- 1980s—WDF implements genetic guidelines for stock transfers and spawning operations.
- 1980s---WDG implements adipose clipping of all hatchery steelhead production.
- 1980s—Tribes and WDF begin to develop Co-Managers Salmonid Disease Control Policy.
- 1985—Puget Sound Management Plan developed under *United States v Washington*. This plan lead to the development of the Future Brood Document, which ensured co-managers reviewed annual production plans so that they complied with legal agreements and mandates, wild stock management needs, and harvest management objectives.
- 1991—WDF and Puget Sound tribes initiate Wild Stock Restoration Initiative.
- 1993—First species in the Salmon and Steelhead Stock Inventory (SASSI) completed which provided baseline information for identifying those salmon runs in need of recovery.
- 1996---Mass Marking of Puget Sound begins with 1995 brood coho.
- 1998—Wild Salmonid Policy formalized to serve as a framework for managing wild salmonids, including habitat, spawner abundance, genetic conservation, ecological interactions, harvest management and hatcheries.
- 2000—WDFW and tribes develop a Risk/Benefits Analysis Procedure (BRAP) for hatchery programs, which provides a systematic method for evaluating genetic and ecological risks of hatchery programs.
- 2000—Western Washington Hatchery Reform Initiative establishes an independent review panel, the Hatchery Scientific Review Group (HSRG), to over-see hatchery reform and provide funding for hatchery reform.
- 2003---WDFW begins to limit cross-basin steelhead plants in the Snohomish and Stillaguamish River Basins.

Operational Changes

The last century has seen operational changes that improved fish culture and focused more and more attention on the status of wild populations. Originally, hatcheries were used to mitigate socially acceptable losses of wild populations. In recent years, however, hatchery operations have begun to emphasize rebuilding wild populations and reducing negative impacts with wild fish. These changes provide the momentum for continued hatchery reform.

- *Limiting cross-basin transfers of salmon stocks:* Once a common practice, this practice has largely been discontinued to protect the local genetic adaptations and to reduce the risk of disease
- *Limiting cross-basin steelhead plants:* Once a common practice, this practice will be limited to minimize delayed out-migration of steelhead smolts.
- *Reduction of fry plants:* Until the 1960s, unfed fry plants were the primary release strategy but they are used today only where it is ecologically and genetically appropriate.
- *Establishment of fish health programs:* Building on the fish disease policy, WDFW and the tribes have developed extensive fish health monitoring and treatment programs to ensure the health of hatchery fish.
- *Development of improved release strategies:* Improved release strategies focus on increasing survival by releasing fish at physiologically appropriate stages and minimizing competition and predation on wild fish.
- *Implementation of recovery programs using hatcheries:* Beginning with the Elwha River Chinook program in 1974, and continuing with the White River Chinook program in 1977, Stillaguamish Chinook in 1980, North Fork Nooksack in 1981, Dungeness River Chinook in 1992 and the Hood Canal Summer Chum in 1992, geneticist and fish culturists have been improving techniques for using artificial propagation at hatcheries to prevent extinction and to maintain genetic diversity of critical stocks.

DESCRIPTIONS OF HATCHERY PROGRAMS

This section summarizes the proposed hatchery operations, strategies, and commitments for WDFW and tribal hatcheries for unlisted species of anadromous salmonids in the Puget Sound. Detailed descriptions are in 72 HGMPs prepared by WDFW and the tribes and provided to NOAA Fisheries (Table 3). Descriptions are organized by major geographic regions of the Puget Sound. Locations of hatcheries are illustrated in Figure 9.

Strait of Juan de Fuca Region

The Puget Sound Chinook Salmon ESU includes two major rivers in the eastern portion of the Strait of Juan de Fuca, the Elwha and Dungeness rivers, and a variety of smaller independent tributaries. The Puget Sound Technical Recovery Team identified two historical populations of Chinook salmon in this region. Populations of at least six other species of anadromous salmon occur in this region, including coho salmon, steelhead, chum salmon, pink salmon, sockeye salmon, Dolly Varden and bull trout, and cutthroat trout. Hatcheries exist on both the Elwha and Dungeness rivers and Snow Creek and include programs directed at recovering and maintaining natural production and augmenting harvest.

Dungeness River

Ecological Context for Hatchery Production
At least 11 stocks of seven species of anadromous salmonids occur in the Dungeness River. The ability to survive for most natural populations for which status has been assessed is threatened by depressed or critically low abundance. Hatchery programs occur on three of these species (Table 4) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

Changes in salmon habitat in the Dungeness River watershed severely constrain natural production of salmonids. The Dungeness watershed is located in a rain shadow of the Olympic Mountains and has an average annual rainfall that ranges from 15 inches in the lower watershed to 50 inches the upper watershed (Pacific Northwest River Basins Commission, 1970). Due to a low storage capacity in the river, stream flows depend upon current-year precipitation levels. Flows generally peak in May and June as snow melts in the Olympic Mountains. Low flows are common in September and October (Smith and Wampler, 1995). Low flows are exacerbated by degraded water quality and quantity from over a century of agriculture and development is a major problem for salmon in the Dungeness River. Irrigation withdrawals have affected the Dungeness River more than any other river in western Washington and the effects on salmon were described in the early 1900s. In addition, diking of the estuary for agriculture and development has extensively modified it from historical condition.

Table 4. Washington Department of Fish and Wildlife (WDFW) and Puget Sound tribal hatchery programs for species of anadromous salmon that are not listed under the Endangered Species Act. WDFW cooperators include regional fishery enhancement groups, Long Live The Kings (LLTK), and the U.S. Fish and Wildlife Service (USFWS).

Region	Watershed	Program (HGMP)	Agencies	Program Type	Releases (x1000)
Strait of Juan de Fuca	Dungeness R.	Dungeness Coho	WDFW	Integrated harvest	550
		Dungeness Steelhead	WDFW	Isolated harvest	10
	Elwha R.	Lower Elwha Coho	Lower Elwha Klallam Tribe	Integrated harvest	750
		Lower Elwha Fall Chum	Lower Elwha Klallam Tribe	Integrated recovery	75
		Lower Elwha Steelhead	Lower Elwha Klallam Tribe	Integrated harvest	150
	Independent	Snow Creek (Hurd Creek) Coho	WDFW	Integrated recovery	54
North Puget Sound	Islands	Glenwood Springs Coho	WDFW Co-op	Isolated harvest	110
		Glenwood Springs Fall Chum	WDFW Co-op	Isolated harvest	110
		San Juan Net Pen Coho	WDFW Co-op	Isolated harvest	15
	Nooksack R.	Kendall Creek Coho	WDFW	Integrated harvest	300
		Kendall Creek Steelhead	WDFW	Isolated harvest	150
		Lummi Nation Coho	Lummi Nation	Integrated harvest	2,000
	Whatcom Ck.	Whatcom Creek Coho	WDFW Co-op	Isolated harvest	5
		Whatcom Creek Fall Chum	WDFW Co-op	Isolated harvest	2,000
		Whatcom Creek Pink	WDFW Co-op	Isolated recovery	1,000
		Whatcom Creek Steelhead	WDFW Co-op	Isolated harvest	40
	Skagit R.	Upper Skagit Fall Chum	Upper Skagit Tribe	Integrated harvest	500
		Baker Lake Sockeye	WDFW	Integrated recovery	1,125
		Baker Lake Coho	WDFW/Puget Power	Integrated harvest	180
		Barnaby Slough Winter Steelhead	WDFW	Isolated harvest	200
		Marblemount Coho	WDFW	Isolated harvest	350
		Marblemount Winter Steelhead	WDFW	Isolated harvest	334
	Stillaguamish R.	Whitehorse Springs Summer Steelhead	WDFW	Isolated harvest	110
		Whitehorse Springs Winter Steelhead	WDFW	Isolated harvest	130
		Stillaguamish (Harvey/Johnson Creek) Coho	Stillaguamish Tribe	Integrated recovery	53.5
		Stillaguamish (Harvey Creek) Fall Chum	Stillaguamish Tribe	Education	250
	Skykomish R.	Wallace River Coho	WDFW	Integrated harvest	150
		Reiter Summer Steelhead	WDFW	Isolated harvest	210
		Reiter Winter Steelhead	WDFW	Isolated harvest	250
		Wallace River Winter Steelhead	WDFW	Isolated harvest	20
	Snoqualmie R.	Tokul Creek Winter Steelhead	WDFW	Isolated harvest	205

Table 3. Continued.

Region	Watershed	Program (HGMP)	Agencies	Program Type	Releases (x1000)
North Puget Sound	Independent	Tulalip Bay Coho	Tulalip Tribes	Isolated harvest	1,000
		Tulalip Bay Fall Chum	Tulalip Tribes	Isolated harvest	8,000
		Laebugton Net Pen Coho	WDFW Co-op	Isolated harvest	25
		Oak Harbor Net Pen Coho	WDFW Co-op	Isolated harvest	30
Mid-Puget Sound	Lake Washington	Ballard Net Pen Coho	WDFW Co-op	Isolated harvest	30
	Lake Washington	Portage Bay Coho	UW/WDFW	Isolated harvest/research	90
	Issaquah Ck.	Issaquah Coho	WDFW	Isolated harvest	450
	Cedar R.	Cedar River Sockeye	WDFW	Integrated harvest	16,000
	Green R.	Elliot Bay Net-pens Coho	Muckleshoot/Suquamish tribes	Integrated harvest	400
		Soos Creek Coho	WDFW	Integrated harvest	950
		Crisp Creek Coho	Muckleshoot Tribe	Integrated harvest	600
		Keta Creek Fall Chum	Muckleshoot Tribe	Integrated harvest	2,000
		Keta Creek Steelhead	Muckleshoot Tribe	Integrated recovery	40-100
		Palmer Pond Summer Steelhead	WDFW	Isolated harvest	80
		Palmer Pond Winter Steelhead	WDFW	Isolated harvest	220
	Independent	Des Moines Net Pen Coho	WDFW Co-op	Isolated harvest	30
		Marine Tech Center Coho	WDFW Co-op	Isolated harvest	25
		Mukilteo Net Pen Coho	WDFW Co-op	Isolated harvest	20
		Possession Point Pond Coho	WDFW Co-op	Isolated harvest	50
		Agate Pass Net-pens Coho	Suquamish Tribe	Isolated harvest	600
		Cowling Creek Fall Chum	Suquamish Tribe	Integrated recovery	2,300
South Puget Sound	Puyallup R.	Puyallup Acclimation Sites Coho	Puyallup Tribe	Integrated recovery	200
		Voights Creek Coho	WDFW	Integrated harvest	780
		Diru Creek Late Fall Chum	Puyallup Tribe	Integrated harvest`	2,000
		Voights Creek Winter Steelhead	WDFW	Isolated harvest	200
	Nisqually R.	Clear Creek Coho	Nisqually Tribe	Isolated harvest	630
		Kalama Creek Coho	Nisqually Tribe	Isolated harvest	350
	Deschutes R.	Tumwater Falls Steelhead	WDFW	Isolated harvest	24.5
	Independent	Minter Creek Coho	WDFW	Isolated harvest	1,044
		Squaxin Island/South Sound Net Pen Coho	WDFW/Squaxin Co-op	Isolated harvest	1,800-2,600
Hood Canal	Big Quilcene R.	Quilcene Net Pen Coho	Skokomish Tribe	Isolated harvest	200
	Independent	Port Gamble Net Pen Coho	Port Gamble S'Kallam Tribe	Isolated harvest	400
		Port Gamble Hatchery Fall Chum	Port Gamble S'Kallam Tribe	Isolated harvest	950
		Hoodsport Fall Chum	WDFW	Isolated harvest	15,000

Table 3. Continued.

Region	Watershed	Program (HGMP)	Agencies	Program Type	Releases (x1000)
Hood Canal		Hoodsport Pink	WDFW	Isolated harvest	1,000
		Hamma Hamma Steelhead	LLTK/WDFW/USFWS	Integrated recovery	2
	Skokomish R.	George Adams Coho	WDFW	Isolated harvest	500
		George Adams Fall Chum	WDFW	Isolated harvest	5,000
Hood Canal	Skokomish R.	McKernan Fall Chum	WDFW	Isolated harvest	10,000
		Eells Springs Winter Steelhead	WDFW	Isolated harvest	72.5
		Enetai Fall Chum	Skokomish Tribe	Isolated harvest	2,500

Figure 7. Location of WDFW and tribal hatcheries in the Puget Sound.

Table 5. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Dungeness River. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Dungeness	Threatened[2]	Isolated recovery/ Integrated recovery
Coho salmon	Dungeness	Depressed[3]	Integrated harvest
Chum salmon	Dungeness summer Dungeness/Eastern Strait fall	Threatened[2] Unknown[3]	- -
Pink salmon	Upper Dungeness Lower Dungeness	Depressed[3] Critical[3]	- -
Steelhead	Dungeness summer Dungeness winter Bogachiel winter (hatchery)	Unknown[3] Depressed[3] NE	- - Isolated harvest
Bull trout/ Dolly Varden[1]	Upper Dungeness Dungeness/Grey Wolf	Healthy[4] Unknown[4]	- -
Cutthroat trout	Eastern Strait stock complex	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)

Hatchery operations in the Dungeness River center around the Dungeness Hatchery, which is located on the Dungeness River (RM 10.5) six miles southwest of Sequim, WA. It is owned and operated by WDFW. Built in 1904 in response to declining salmon abundance and renovated several times over the last century to keep up with advances in aquaculture, the Dungeness Hatchery is one of the oldest hatcheries in the Puget Sound. The facility was built to increase production of coho salmon, Chinook salmon and winter steelhead. Hurd Creek Hatchery is a satellite facility that has been used to rear Dungeness River Chinook salmon for the captive brood stock program, the summer chum salmon rebuilding program in Sequim Bay and Discovery Bay, Dungeness fall pink salmon recovery program, and a Discovery Bay coho salmon rebuilding program.

Coho Salmon

Dungeness River Coho Program: Coho salmon are produced at the Dungeness Hatchery through an integrated harvest program with an annual release of approximately 500,000 smolts at a size of 17 fpp (137 mm fl). Smolts are released on-station after June 1 as a risk aversion measure for listed Chinook juveniles, listed summer chum fry, and pink salmon. This program has been reduced from the 1993 through 1998 brood year release of 800,000 to the present level of 500,000. In addition, 50,000 eggs are planted in gravel of an engineered streambed from where resulting smolts volitionally migrate. To attain an egg take goal of 600,000, 500 adults (1:1) are collected.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Reduce program size by 38% from the 1993 through 1998 brood year level of approximately 800,000;
2) Delay the release of coho salmon smolts from April until after June 1 to allow Chinook salmon to grow to a size that reduces the potential for predation; and
3) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 5.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Dungeness Hatchery for broodstock. Coho collection and spawning takes place from late October to early December while listed spring Chinook are entering and spawning in the river July through September. Any spring Chinook salmon which do enter the pond will be returned to the river.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho salmon for on-station release to a total maximum of 500,000 yearlings at a size of 17 fpp (137 mm fl) (HSRG recommendation). The program has been reduced by 38% from the 1993 through 1998 brood year level of 800,000 smolts.

- WDFW will release coho salmon after June 1 to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the program to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 6. Summary of risk aversion measures for the Dungeness River Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from the Dungeness River is regulated under permits 3518 - 1944 (25CFS) and S2-21709C - 1973 (15CFS). Water used in the hatchery is routed to the river immediately below the hatchery. A backup water source on Canyon Creek, permit S2-00568C - 1970 (8.5CFS), is used when the Dungeness River is excessively silty or icy.
Intake Screening	4.2	Intake screens may not be compliant with NOAA fish screening standards. WDFW has committed funds for the immediate scoping, design, and construction work of a new intake system.
Effluent Discharge	4.2	Effluent is routed through an off-line settling pond and artificial wetland prior to discharged back into the river (regulated through NPDES permit WAG131037).
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter an off-channel pond in a time period (October through early December) when spring Chinook are not typically present. Any Chinook salmon that enter the pond are returned to the river.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released after June 1 to allow Chinook salmon to grow to a size that reduces the potential for predation. Program size reduced by 38% since 1998. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Steelhead

Dungeness River Steelhead Program: Winter steelhead are produced at the Dungeness Hatchery through an isolated harvest program with an annual release of approximately 10,000 smolts at a size of 5 fpp (206 mm fl). Smolts are released on-station after June 1 as a risk aversion measure for listed Chinook juveniles, listed summer chum fry, and pink salmon. A 10,000 fish program requires a minimum of six adults. However, it is desirable to collect a larger number of adults (up to 30) and take a proportional amount from each female to obtain 10,000 eggs.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program may pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Delay the release of steelhead smolts from April until after June 1; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 6.

Operational Commitments:

- WDFW will continue to work at collecting steelhead adults at the Dungeness Hatchery for broodstock. Collection and spawning of steelhead would take place between December and February. Listed Chinook salmon are unlikely to be impacted by steelhead broodstock collection.

- WDFW will limit, as the management intent, annual production of steelhead for on-station release to a total maximum of 10,000 yearlings at a size of 5 fpp (206 mm fl).

- WDFW will release steelhead after June 1 to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the steelhead will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interaction with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released from the program to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the scoping, design, and construction work of a new intake system that includes removal of the intake barrier on Canyon Creek (HSRG recommendation).

- WDFW will install a propane water heater to address water temperature concerns (HSRG recommendation).

Table 7. Summary of risk aversion measures for the Dungeness River Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from the Dungeness River is regulated under permits 3518 - 1944 (25CFS) and S2-21709C - 1973 (15CFS). Water used in the hatchery is routed to the river immediately below the hatchery. A backup water source on Canyon Creek, permit S2-00568C - 1970 (8.5CFS), is used when the Dungeness River is excessively silty or icy.
Intake Screening	4.2	Intake screens may not be compliant with NOAA fish screening standards. WDFW has committed funds for the scoping and design of a new intake system.
Effluent Discharge	4.2	Effluent from the Dungeness Hatchery is regulated through NPDES permit WAG 13-1037.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter an off-channel pond in a time period (October through early December) when spring Chinook are not typically present. Any Chinook that enter the pond are returned to the river.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predaton	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released after June 1 to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Elwha River

Ecological Context for Hatchery Production
At least 10 stocks of seven species of anadromous salmonids occur in the Elwha River. The ability to survive for most natural populations for which status has been assessed is threatened, depressed, or critical status. Hatchery programs occur on four of these species (Table 7) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

Dams constructed early in the 20th Century severely limit natural production of salmonids in the Elwha River. The Elwha, which originates deep within the Olympic Mountains, is the largest river draining into the Strait of Juan de Fuca. Two dams located at river miles 4.9 and 13.4 block passage of salmon to the majority of the watershed. Much of the watershed above the dams is in the Olympic National Park, where habitat for salmon is excellent. Below the dams, the river drops quickly from moderate to low gradient until it empties into a limited estuary. The flood plain and river channel below the dams have been altered by construction of dikes, water diversions, and development. Likewise the estuary has been significantly changed by diking and loss of sediment transport from the Elwha River.

Table 8. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Elwha River. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Elwha[6]	Threatened[2]	Isolated recovery/ Integrated recovery
Coho salmon	Elwha	Unknown[3]	Integrated harvest
Chum salmon	Elwha Fall (native) Elwha Fall (introduced)	Unknown[3] Unknown[3]	Integrated recovery -
Pink salmon	Elwha	Critical[3]	-
Steelhead	Summer steelhead Winter steelhead	Unknown[3] Depressed[3]	- Isolated harvest
Bull trout/ Dolly Varden[1]	Lower Elwha Upper Elwha	Unknown[4] Unknown[4]	- -
Cutthroat trout	Mid-Strait stock complex	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Although at the time the Elwha dams were constructed it was illegal under state law to obstruct anadromous salmon runs, the law was changed to allow constructions of dams if the loss of natural production could be mitigated by hatchery production. Early efforts to mitigate for for lost salmon runs in the Elwha River using hatcheries were abandoned by 1922. Today, hatchery operations in the Elwha River occur in the Lower Elwha Fish Hatchery, which is operated by the Lower Elwha Klallam Tribe near the mouth of the Elwha River, and the Elwha Rearing Channel, which is operated by WDFW. The program and facilities at Elwha Rearing Channel are described in the Chinook salmon resource management plan. The Lower Elwha Hatchery is located at river mile 0.3 near the estuary and consists of an earthen brood stock holding pond, incubation facilities, 24 concrete raceways, eight fiberglass circular rearing tanks, four asphalt rearing ponds, and one earthen rearing pond. The hatchery uses ground water, surface water, or a combination of both.

Coho Salmon

Lower Elwha Fish Hatchery: The purpose of this program is to provide fish for harvest while minimizing potential effects on listed Chinook salmon. The program began in 1978. The program goal is to release 750,000 smolts produced from 1,200 brood stock returning to the Elwha River capture facility. Fish are spawned and eggs are incubated at the hatchery. Hatched fry are moved to raceways for early rearing and later to rearing ponds or circular tanks. Two methods of fingerling rearing are used as part of a study of effective rearing methods. One group is reared using tradition rearing protocols while the other group is reared under a modified natural rearing strategy that includes reduced rearing densities, increased emphasis on natural foods, and more natural cover and structure. Migratory coho salmon are released volitionally from the hatchery in May. Surveys indicate that smolts released from the hatchery do not move upstream. Instead, these fish enter the river near the estuary and either move directly into the Strait of Juan de Fuca or they acclimate for a short period in a series of estuarine beach lakes before moving into the strait.

Effects of this program on Chinook salmon are minimal. Brood stock collection has little negative impact on Chinook salmon. A total of less than 50 Chinook salmon have been encountered during brood stock capture during the last 10 years of hatchery operation. These are either carefully returned to the river or transported to the Elwha Rearing Channel for use in the Chinook salmon recovery program. Potential disease impacts of the coho program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. The program minimizes potential competition and predation by coho salmon on Chinook salmon by releasing migratory salmon very low in the river nearly a month before Chinook salmon are released from the Elwha Rearing Channel. Potential interactions in estuarine beach lakes are minimized by annually surveying estuarine habitat for listed species and timing releases of fish to minimize interactions. This minimizes potential overlaps in space and time between the species before their marine life history phase.

Steelhead

Lower Elwha Fish Hatchery: The purpose of this program is to provide fish for harvest while minimizing adverse ecological interactions with Chinook salmon. The program began in 1976 using a composite of introduced stocks with an early (December-February) adult return timing. The program goal is to release 150,000 smolts produced from 120 adults taken from early-returning steelhead entering the collection facility. Fish are spawned and eggs are incubated at the hatchery. Hatched fry are moved to raceways for early rearing and later to rearing ponds or circular tanks. Steelhead releases uses two strategies. Migratory steelhead are released from the Lower Elwha Hatchery as yearlings (6 fpp) in May. These fish enter the Elwha River at river mile 0.3 in an estuarine zone influenced by tidal fluctuations. Surveys indicate that smolts released from the hatchery do not move upstream. In March, up to 120,000 pre-migratory juveniles are transferred to the WDFW Elwha Rearing channel at RM 3.2 where they acclimate for an additional two months before being released into the river and migratory smolts. Fish leave the facilities volitionally and either move directly into the Strait of Juan de Fuca or they acclimate for a short period in a series of estuarine beach lakes before moving into the strait.

Effects of this program on Chinook salmon are minimal. Broodstock collection has no negative impact on Chinook salmon. Adult Elwha River Chinook salmon are not present in the river during the time that steelhead broodstock are collected. Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. The program minimizes potential competition and predation by steelhead on Chinook salmon and other species by releasing migratory fish at times where outmigrating juveniles of other species are less present in the river. Steelhead releases are timed to minimize interactions with outmigrating chum and pink salmon (late March through mid-May) and Chinook salmon (mid-to-late June). This minimizes potential overlaps in space and time between the species before their marine life history phase.

Fall Chum Salmon

Lower Elwha Fish Hatchery: The purpose of this program is to assist in the recovery of chum salmon in the Elwha River while minimizing the adverse ecological effects on listed stocks of Chinook salmon. The program began in 1995 and is planned to last for 12 years. The program goal is to produce 75,000 eggs or fry for release from 100 broodstock. From 1976-1985, the hatchery supported an integrated harvest program based on broodstock taken from Wolcott Slough, Enatai Creek, Lyre River, and Elwha River. In 1981, the chum salmon program began using eggs exclusively from adults returning to the Elwha River. Introduction of non-local chum salmon, however, has resulted in early returning chum salmon, which are native to the river, and later returning fish that are genetically more similar to introduced stocks. Broodstock collection for this recovery program focuses on the earlier returning fish. Fish are collected by gill netting in side channels and main stem of the river. Fish are spawned and eggs are incubated at the hatchery. Fish are reared and released in two ways. Eyed eggs to be remotely incubated are transferred to remote egg incubators, transported to remote locations, and buried in gravel during December-February. Hatching and volitional migration of the fish occurs from the remote incubator. Eggs to be hatched at the hatchery are incubated in the incubation facility and transferred to rearing containers as button-up fry. Fry are released at Bosco Slough during March-April.

Effects of this program on Chinook salmon are minimal. Brood stock collection has no negative impact on Chinook salmon. Adult Elwha River Chinook salmon are not present in the river during the time that chum salmon brood stock are collected. Potential disease impacts of the program are controlled through regular monitoring and treatment if necessary. Because the number of fish released is small compared to other species, they are released nearly 2-3 months earlier than Chinook salmon and soon migrate to the Strait, and they are of small size (45 mm), the potential for predation and competition on Chinook salmon is minimal. Timing of chum salmon is more important to ensure that they survive potential predation or competition from coho salmon and steelhead.

Independent Bays and Tributaries

This region includes the independent streams that enter the Strait of Juan de Fuca east of the Elwha River and those flowing into Sequim Bay, Discovery Bay, and Port Townsend Bay.

Ecological Context for Hatchery Production
At least 12 stocks of five different species of anadromous salmonids use these streams. These small, lowland, independents tributaries and bays mainly produce coho salmon, summer chum salmon, winter steelhead, and cutthroat trout. Chinook salmon from the Elwha or Dungeness rivers may use some of the larger streams, but they are not self-sustaining. Hatchery programs occur on two of these species (Table 8) and are focused on assisting in recovering the natural population.

Table 9. Anadromous salmonid species, stocks, stock status, and hatchery strategies in independent bays and tributaries of the Strait of Juan de Fuca

Species	Natural Populations	Status	Hatchery Strategy
Coho salmon	Chimacum Creek	Healthy[3]	-
	Discovery Bay (Snow Cr)	Critical[3]	Integrated recovery
	Sequim Bay	Depressed[3]	-
	Morse Creek	Depressed[3]	-
Chum salmon	Jimmycomelately summer	Threatened[2]	Integrated recovery
	Snow/Salmon summer	Threatened[2]	Integrated recovery
	Chimacum summer	Threatened[2]	Reintroduction
Steelhead	Discovery Bay winter	Healthy[3]	-
	Sequim Bay winter	Unknown[3]	-
	Morse Creek/Independents winter	Depressed[3]	Isolated harvest
Cutthroat trout	Eastern Strait complex	Unknown[4]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 2000 SaSI status (WDFW 2000)

The impacts of agriculture, forestry, and development limit natural production in these areas. Much of the area is in the rainshadow of the Olympic Mountains and receives 15-20 inches of rain annually compared to 70-80 inches in the Olympic Mountains. Species that require freshwater rearing habitat through the summer months have been especially affected by the combination of low precipitation and habitat alterations that dewater streams and raise stream temperatures. Agricultural activities have channelized streams, decreased channel complexity, eliminated beaver ponds and pools for rearing, and altered riparian areas. Rural development has tended to increase stormwater runoff and impaired water quality by the introduction of pesticides, herbicides, and fertilizers. The estuarine and nearshore habitats of this area provide migration corridors and rearing habitat for all species of salmonids. In the intertidal regions, however, fill has eliminated shallow water habitat used by salmonids and their prey (Correa 2002).

Coho Salmon

<u>Snow Creek Coho Salmon Supplementation Program:</u> WDFW operates a coho salmon program at Snow Creek, an independent tributary to Discovery Bay (Figure 9). Snow Creek contains a summer chum population, but the PSTRT has not identified a Chinook population originating in this location. The purpose of this program is to contribute to the restoration of a healthy, natural, self-sustaining population of coho salmon that will maintain the genetic characteristic of the native stock. The broodstock collection site is located at the WDFW trap on Snow Creek at RM 0.8. Broodstock collection levels are 100% of the run, up to 100 adults. Eggs are incubated at the Hurd Creek Hatchery (RM 13) on Hurd Creek (Figure 9), a tributary to Dungeness River at RM 3. Un-fed fry volitionally release from a Remote Site Incubator (RSI) on Snow Creek located at RM 4 and from an RSI site on Andrews Creek (tributary to Snow Creek) at RM 1.5. Approximately 18,000 are released from each of the above sites. Also, 9,000 fingerlings and 9,000 yearlings are planted into Crocker Lake.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program may pose to listed summer chum salmon populations. The

Summer Chum Salmon Conservation Initiative considered the need for additional risk aversion measures that could be applied to this program to help minimize potential interactions to summer chum. When the value of the program for recovery of the indigenous coho salmon population was considered, it was decided to leave the coho supplementation and release program unaltered, but required that coho salmon juveniles rearing in Snow Creek as a result of the supplementation program be monitored to identify survival rates and in-stream distribution in order to evaluate predation effects on summer chum salmon.

Operational Commitments:

- WDFW will continue to operate the program as designed (HSRG recommendation). This includes the of use gametes from coho salmon adults volunteering into the WDFW trap on Snow Creek for broodstock. Coho collection and spawning takes place between October and January. There may be an overlap with returning summer chum in October, but most, if not all, have spawned in the lower reaches of the creek (below trap).

- WDFW will limit, as the management intent, annual production of coho for release to a total maximum of 54,000 fish.

- WDFW will have 36,000 unfed fry from Remote Site Incubators (RSI's) located on Snow Creek and Andrews Creek volitionally migrating between the months of March and May at approximately 1,275 fpp (38mm fl), 9,000 fingerlings at 50 fpp (92mm fl) will be planted into Crocker Lake in November and another 9,000 yearlings at 25 fpp (115mm fl) will be planted into the same lake in February.

- WDFW will differentially otolith mark all eggs for the Snow Creek RSI, Andrews Creek RSI and Crocker Lake groups. Blank coded-wire tags will be inserted into the snouts of juveniles destined for fall release (November). Blank coded-wire tags will be inserted in the adipose fins of juveniles destined for spring release (February). This will allow for monitoring and evaluation of the supplementation program as per in-stream distribution , survival rates and adult returns.

Table 10. Summary of risk aversion measures for the Snow Creek Coho Salmon Supplementation program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Remote Site Incubators (RSIs) at Snow and Andrews creeks are located above natural barriers to fish migration and are gravity fed by springs with water subsequently routed to the creeks. Usage of well water and surface water from Hurd Creek is regulated under permit G2-24026c and G2-25021c. (6.4 cfs).
Intake Screening	4.2	Intake structures are located above natural barriers to fish migration on Snow and Andrews creeks. Surface water intake structures at Hurd Creek were updated to be compliant with NOAA fish screening standards in 2000.
Effluent Discharge	4.2	The Hurd Creek Hatchery and the Snow and Andrews creek remote facilities each produce less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects and for the requirement for an NPDES permit.
Broodstock Collection & Adult Passage	7.9	Coho salmon are collected at a trap on Snow Creek where few, if any, listed Chinook salmon are present. Summer chum enter Snow Creek from August through October; any summer chum encountered during broodstock collection for this program (occurring from October through January) will be returned to Snow Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	The Puget Sound Technical Recovery Team has not identified Snow Creek as a Chinook salmon population. Competition with summer chum is minimized by differences in life history traits and feeding habits between the species. Other potential impacts of this program on summer chum are limited by the size and duration (maximum of 9 years) of the program.

North Puget Sound Region

This region consists of the San Juan Islands, Nooksack and Samish river systems, Skagit River, Stillaguamish River, and Snohomish River watersheds. There are a number of coho and steelhead releases within this region, including marine net pen operations as well as freshwater releases from hatcheries.

San Juan Islands

Ecological Context for Hatchery Production
No known independent populations of anadromous salmonids occur in the San Juan Islands. Lack of access to streams with suitable flows or gradients for salmon to spawn and incubate limits natural production to intermittent use by coho and chum salmon (Williams et al., 1975, WDNR, unpublished data), A small spawning aggregation occurs in Cascade Creek on Orcas Island, but its origin is unknown.

Physiographically, the region lies at the center of the Puget Sound ESU and consists of 470 solid rock outcroppings with natural vegetation and small streams on the largest of the islands. Overall, the approximately different 85 streams provide 100-158 linear miles (Williams et al. 1975, WDNR, unpubished data). Because of its central location in the ESU and the unique combination of tidal and marine physical, chemical, and biological forces that act in this region, it is extremely important as a nursery and feeding ground for juvenile and adult salmonids on their way to and from the Pacific Ocean. The region provides diverse marine riparian vegetation, tidal marshes and flats, eelgrass meadows, and kelp forest that sustain populations that spawned in other freshwater streams. Forage fish using this area include herring, surf smelt and Pacific sand lance. Development, including overwater structures, shoreline armoring, and contamination all contribute to loss of nearshore habitats and productivity of salmon.

Two hatchery facilities exist in the San Juan Islands. Glenwood Springs is located on the eastern shore of East Sound, Orcas Island, Washington. The facility is located on 300 acres of private property. It includes the springs that supply water to the hatchery and associated rearingponds, the entire “watershed” and the saltwater bay to which the fish return. Long Live the Kings operates the program cooperatively with WDFW. In addition, WDFW operates a net pen in Roche Harbor on San Juan Island.

Coho Salmon

Glenwood Springs Coho Program: Coho salmon are produced through an isolated harvest program with an annual release of approximately 100,000 smolts. No populations of listed salmonids have been identified in this watershed. This cooperative program between the WDFW and Long Live the Kings releases both fry and smolts. A smaller group of 10,000 fry are released into Westsound in April at 600 fpp (42 mm fl); 100,000 are released in April into Eastsound (Orcas Island) when the fish are 15 fpp (143 mm fl). Broodstock (90 – 100 adults) returning to the hatchery are typically used for broodstock. If an adequate number of eggs are not available from returning adults, WDFW’s Kendall Creek Hatchery supplies additional eggs.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location. Competition or predation impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 10.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Glenwood Springs trap for broodstock when sufficient numbers are available. Collection and spawning of coho salmon takes place from October through November. No known listed stocks are in the watershed. Source of fish for the program when returns have not been sufficient has been the Kendall Creek facility.

- WDFW will limit, as the management intent, annual production of coho for on-station release (Eastsound) to a total maximum of 100,000 yearlings in April at a size of 15 fpp (143mm fl).

- WDFW will limit, as the management intent, annual production of coho fry for release in Westsound to a total maximum of 10,000 fry in April at a size of 600 fpp (42 mm fl).

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 11. Summary of risk aversion measures for the Glenwood Springs Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	No listed species are present within the water source.
Intake Screening	4.2	No listed species are present within the water source.
Effluent Discharge	4.2	No listed species are present within the water source. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	No listed species are present at the broodstock collection facility for Glenwood Springs.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Location of program eliminates potential for predation and competition with listed species in freshwater. Studies will be conducted in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>San Juan Net Pen Coho Program</u>: This cooperative program between the WDFW and the Friday Harbor Marina releases 15,000 coho smolts from a net pen in Roche Harbor. Fish are released at a size of 15 fpp (143 mm fl) in June. Broodstock collection and initial rearing of the smolts occurs at the Marblemount Hatchery on the Skagit River.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location. Competition or predations impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 11.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of coho for release from a net pen in Roche Harbor to a total maximum of 15,000 yearlings.

- WDFW will release coho in June from the net pen at 15 fpp (143 mm fl) todecrease time spent in the nearshore area and minimize the likelihood for interaction with natural Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 12. Summary of risk aversion measures for the San Juan Net Pen Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water at Marblemount Hatchery is regulated under the following permits: S1-23230c, S1-06773c, S1-06774c, S1-21701c, S1-00419c, and S1-20241c.
Intake Screening	4.2	Intake screens at Marblemount Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Marblemount Hatchery is regulated through NPDES permit WAG 13-3015.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter an off-channel pond at Marblemount Hatchery. Any unmarked Chinook that enter the pond are returned to the river.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Location of program eliminates potential for predation and competition with listed species in freshwater. Studies will be conducted in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Chum Salmon

Glenwood Springs Chum Program: Fall chum salmon are produced through an isolated harvest program with an annual release of approximately 180,000 fry. No populations of listed salmonids have been identified in the Glenwood Springs watershed. This is a cooperative program of WDFW and Long Live the Kings.

The program currently relies on the collection of broodstock at the Kendall Creek Hatchery and incubation at Whatcom Creek Hatchery. However, releases of chum salmon from Kendall Creek Hatchery were terminated in 2003, and the final return of adults from this release are expected to occur in 2007. As the Kendall Creek Hatchery program is phased out, broodstock collection will be shifted to the Whatcom Creek Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location and species released. Ongoing and proposed risk aversion measures for this program are summarized in Table 12.

Operational Commitments:

- Long Live the Kings (WDFW) will limit, as the management intent, annual production of fall chum for on-station release from the Glenwood Springs facility to a total maximum of 180,000. The current egg source is the Kendall Creek Hatchery. As the Kendall Creek chum salmon program is phased out, the broodstock source will be shifted to the Whatcom Creek facility.

- Long Live the Kings (WDFW) will release fall chum at 600 fpp (42 mm fl) in April.

Table 13. Summary of risk aversion measures for the Glenwood Springs Chum program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Broodstock Collection: Water is obtained from wells and Kendall Creek surface water under the following permits: G1-10562c, G1-23261c, S1-23273 and S1-0031c. Incubation: No listed salmonids are present within the water source at Whatcom Creek.
Intake Screening	4.2	Broodstock Collection: Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed salmonids. Incubation: No listed salmonids are present within the water source at Whatcom Creek Hatchery.
Effluent Discharge	4.2	Broodstock Collection: Effluent is regulated through NPDES permit WAG 13-1037. Incubation: No listed species are present within Whatcom Creek. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	The Puget Sound Technical Recovery Team has not identified Whatcom Creek as a Chinook salmon or summer chum population.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history and feeding habits of fall chum salmon are expected to result in limited competition with listed Chinook and summer chum. Fall chum salmon predation on listed Chinook and summer chum is expected to be limited.

Nooksack-Samish Watersheds

This region includes the Nooksack and Samish Rivers, their tributaries, independent streams (California, Dakota, Terrell, Squalicum, Whatcom, Padden, Chuckanut and Oyster creeks), and tributaries to the Fraser River.

Ecological Context for Hatchery Production
At least 29 stocks of eight species of anadromous salmonids occur in the Nooksack-Samish River watershed and transboundary areas. The potential to survive for most natural populations given habitat alterations is unknown. Hatchery programs occur on eight of these stocks (Table 13) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

The Nooksack River is the main salmonid producing river in this area. Salmon production in the river is limited by sedimentation, which has been aggravated by road building and timber harvests, alteration of riparian and flood plain areas, water quantity and water quality problems associated with agricultural and urban development, and loss of estuary habitat. The three forks of the Nooksack River have very different environments. The North Fork Nooksack originates from the East Nooksack Glacier and drains the west slopes of the Skagit Range and the North slopes of Mt. Shuksan and Mt. Baker (Dept. of Conservation, 1960). During spawning season, the North Fork Nooksack is typically turbid with moderate flows due to the glacial input. Glacial inputs create naturally high sediment loads, but road building and timber harvest have increased sedimentation dramatically. Of an estimated 1112 landslides in these forks, 36% were associated with road and 28-32% were associated with clearcuts (Smith 2002).

The South Fork drains the western slopes of the Twin Sisters Mountain. The non-glacial, low elevation South Fork has peak flows in May and December, and its lowest flow in August (Dept. of Conservation, 1960). Consequently, during the spawning season, the waters of the South Fork Nooksack are clear but habitat alterations, loss of deeper water refugia, and low flows raise water temperatures to levels that affect salmon. Water temperatures have risen as high as 23.9°C and 52% of the observations have been above 20°C. In addition, 60% of the South Fork has been diked resulting in loss of secondary channels and an overall decrease stream length (Smith 2002).

In the smaller, independent tributaries, water use and changes in land cover leading to water quantity and quality problems and toxicants from urban, industrial, and agricultural runoff may be limiting fish production. Estuaries have also been modified from historical conditions that supported natural populations of salmonids. Loss of estuarine habitat has been documented in Bellingham, Lummi, and Samish bays. Water quality and sediment contamination by toxins, including mercury, arsenic, and PCBs that can affect salmonids directly and be lethal to salmon prey, has occurred in Bellingham Bay (Smith 2002).

Both the Lummi Tribe and WDFW operate hatchery programs in the Nooksack-Samish watersheds. The WDFW Nooksack Hatchery Complex includes Kendall Creek Hatchery, Samish Hatchery, Lake Whatcom Hatchery and Bellingham Hatchery. Kendall Hatchery is located on Kendall Creek, a tributary of the Nooksack River, 21 miles northeast of Bellingham. The hatchery was built in 1899 and was operated until 1939, and re-started in 1952. Many improvements have been added in recent years. This facility has incubation and rearing capabilities and has been used for Chinook, coho, chum and pink salmon as well as steelhead. Samish Hatchery is located on Friday Creek, a tributary of the Samish River. This facility also has both incubation and rearing capabilities. In addition, there are two private facilities, Bellingham Maritime Heritage facility, located on lower Whatcom Creek, and the Squalicum

Table 14. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Nooksack-Samish watershed. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	North Fork Nooksack[6]	Threatened[2]	Integrated recovery
	South Fork Nooksack[6]	Threatened[2]	-
	Samish (hatchery)	NE	Isolated harvest
Coho salmon	Lower Nooksack	Unknown[3]	Integrated harvest
	Upper Nooksack	Unknown[3]	-
	Samish	Healthy	-
	Sumas/Chilliwack	Unknown[3]	-
	North Puget Sound tributaries	Unknown[3]	-
Chum salmon	North Fork Nooksack	Healthy[3]	-
	Whatcom Creek	NE	Isolated harvest
	Mainstem/South Fork	Healthy[3]	-
	Samish/Independents	Healthy[3]	-
	Sumas/Chilliwack	Unknown[3]	-
Pink salmon	North Fork/Middle Fork	Healthy[3]	Integrated recovery
	South Fork	Unknown[3]	-
Sockeye salmon	Nooksack riverine	Unknown	-
Steelhead	South Fork summer	Unknown[3]	-
	South Fork winter	Unknown[3]	-
	Mainstem/North Fork winter	Unknown[3]	-
	Kendall Creek winter	NE	Isolated harvest
	Whatcom Creek winter	NE	Isolated harvest
	Middle Fork winter	Unknown[3]	-
	Dakota Creek winter	Unknown[3]	-
	Samish winter	Depressed[3]	-
Bull trout/ Dolly Varden[1]	Chilliwack/Selesia Creek	Unknown[4]	-
	Lower Nooksack	Unknown[4]	-
	Canyon Creek	Unknown[4]	-
	Upper Middle Fork	Unknown[4]	-
Cutthroat trout	Nooksack	Unknown[5]	-
	Whatcom Creek	Unknown[5]	-
	Samish	Unknown[5]	-
	Sumas	Unknown[5]	-
	North Puget Sound tributaries	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Harbor Net Pens. Lake Whatcom Hatchery and Bellingham Hatchery rear trout and kokanee for releases into lakes in Whatcom and Skagit counties, and in other areas in Washington, Idaho, and California. Tribal facilities include Skookum Hatchery on the South Fork Nooksack, Lummi Sea Ponds, and Kwina Slough (Mamoya Ponds) located on the lower Nooksack, within the Lummi Reservation.

Coho Salmon

Kendall Creek Coho Program: Coho salmon are produced at the Kendall Creek Hatchery through an integrated harvest program with an annual release of approximately 300,000 smolts at a size of 17 fpp (130 mm fl). This program has been reduced from the previous program of 2,000,000 (including fry plants) to the present level of 300,000. Smolts are released on-station in May as a risk aversion measure for listed Chinook juveniles. Broodstock requirements call for 700-900 adults (1:1; male:female) for an egg take goal of 600,000.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program may pose to listed Chinook salmon populations. A review of the program suggested the following program modifications, in addition to the reduction of the program from 2,000,000 to 300,000 already implemented, as risk aversion measures to address these potential hazards:

1) Release coho salmon yearling smolts during a time period when the Nooksack River is high and turbid; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 14.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Kendall Creek Hatchery for broodstock. Coho collection and spawning takes place from October to December while listed Chinook are collected and spawned from April to September. Therefore, coho broodstock collection is expected to have a limited impact on listed Chinook salmon.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 300,000 yearlings at a size of 17 fpp (130mm fl). The release level has been reduced by 70% from the 1994 through 1996 release level of approximately 1.0 million smolts. Releases of up to 1.5 million fry have been eliminated.

- WDFW shall release coho in mid to late May during high spring glacial runoff to foster rapid migration to salt water and to provide visual protection for listed Chinook salmon juveniles. This helps minimize possible interaction with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will apply a double index coded-wire tag group (DIT) to allow for selective fisheries, the evaluation of fishery contribution, overall survival rates and straying levels to other Puget Sound watersheds.

- WDFW will commit funds for the scoping and design of a well field and water distribution system (HSRG recommendation).

Table 15. Summary of risk aversion measures for the Kendall Creek Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from wells and Kendall Creek surface water under permits G1-10562c, G1-23261c, G1-23273a, and S1-00317c. Water used in the hatchery is routed to Kendall Creek immediately below the hatchery.
Intake Screening	4.2	Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed species.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1037.
Broodstock Collection & Adult Passage	7.9	Coho salmon are collected in a time period (October through December) when spring Chinook are typically not present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation and corresponds to a period of high, turbid flows in the Nooksack River. Yearling program size reduced by 70% since from the 1994 through 1996 brood year level; annual release of up to 1.5 million fry eliminated. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Whatcom Creek Coho Program – Squalicum Harbor Net Pens: This is an integrated harvest program that also provides educational benefits to students attending the Bellingham Technical College. The PSTRT has not identified populations of Chinook or summer chum salmon in Whatcom Creek. Broodstock is taken at Kendall Creek Hatchery with juvenile fish transferred to the net pen site in Squalicum Harbor, Bellingham, Washington. The students rear and release 5,000 coho in mid-April at 15 fpp (136 mm fl). The program has been reduced by 97% from the 1993 through 1996 brood year release of 175,000.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location and the reduction in the size of the progam from

175,000 to 5,000 yearling smolts. Competition or predation impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 15.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of coho for release from a net pen in Squalicum Harbor to a total maximum of 5,000 yearlings at a size of 15 fpp (136 mm fl) (HSRG recommendation). The release level has been reduced by 97% from the 1993 through 1996 brood year level release level of 175,000 fish.

- WDFW will release coho in April from the net pen at a time and location to minimize the likelihood of interactions to listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 16. Summary of risk aversion measures for the Whatcom Creek Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from wells and Kendall Creek under permits G1-10562c, G1-23261c, G1-23273a, and S1-00317c. Water used in the hatchery is routed to Kendall Creek immediately below the hatchery.
Intake Screening	4.2	Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed species.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1037.
Broodstock Collection & Adult Passage	7.9	Coho salmon are collected in a time period (October through December) when spring Chinook are typically not present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager’s Salmonid Disease Control Policy.
Competition & Predation	10.11	Location of program eliminates potential for predation & competition with listed species in freshwater. Program size reduced by 97% from the 1993 through 1996 brood year level. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Lummi Nation Coho Salmon: The purpose of this program is to produce coho salmon to support tribal treaty-right fisheries in Bellingham Bay and the Nooksack River and obligations and under the Pacific Salmon Treaty by mitigating for natural production lost through habitat degradation. The program began in 1971 in Lummi Bay and was expanded to Skookum Creek Hatchery in 1977. Introductions of Green River coho salmon were used to develop the hatchery stock, but since 1987 brood stock have been collected from coho salmon returning to the two facilities. Genetic data indicates that hatchery fish and wild fish interbreed in the lower Nooksack River (identified in SaSI as “Nooksack Coho” stock), but the upper Nooksack River coho salmon stock are genetically distinct and isolated (Small 2003).

Between 800-1000 males and 800-1000 females at each facility provide the production to release 2 million yearling coho salmon in Lummi Bay and South Fork Nooksack River annually. At Skookum Creek, adults entered the holding ponds from a channel to the River. At the Lummi Bay Sea Pond facility, adults enter a capture pond at the tidegate and brood stock are subsequently transported to holding ponds before spawning. Fish are spawned at each facility andeggs are incubated on well water at Skookum Creek hatchery. Hatched fry are transferred to 12 concrete raceways for initial rearing. At 250-300 fish/pound, fingerlings are marked by adipose clips and/or coded-wire tags and transferred to asphalt rearing ponds. One-half of the production is transferred to Lummi Bay Sea Pond in mid-April for final rearing and acclimation in net pen enclosures in the southwest corner of Lummi Bay. Yearling coho salmon are released volitionally over a 2-week period usually in mid-May from Skookum Creek Hatchery and the Lummi Bay Sea Pond.

The potential effects of this program on listed Chinook salmon have been significantly reduced by changes in the program. Brood stock collection has little negative impact on Chinook salmon or bull trout. Most early returning North Fork and South Fork Chinook salmon have entered the river by the time that coho salmon brood stock collection begins in October and are unlikely to enter the brood stock collection ponds. Main stem fall Chinook salmon can enter the facility, however, but this is rare (1-2 per year) and when encountered are carefully removed to the river. Water in-take screens at both facilities meet WDFW screening requirement and when improvements are completed will meet NOAA Fisheries guidelines. Potential disease effects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. In addition, the program has made large changes in production of coho salmon to reduce impacts on listed fish from predation and competition. Overall, the target number of coho salmon released in the watershed has been reduced nearly 80% from 11 million to 2.35 million, with the Lummi Nation program reducing its releases 67% from 6 million to 2 million. The tribe is also exploring other techniques to reduce predation and completion, such as delaying release of coho salmon or transporting them to releases sites in the bay.

Winter Steelhead

Kendall Creek Winter Steelhead Program: Winter steelhead are produced at the Kendall Creek Hatchery through an isolated harvest program with an annual release of approximately 150,000 smolts at a size of 5 fpp (206 mm fl). A portion of these fish (50,000) are reared at McKinnon Pond, then trucked back to Kendall Creek where they are acclimated and released. Smolts are released on-station in May as a risk aversion measure for listed Chinook juveniles. Between 80-100 adults (1:1; male:female) are needed to attain an egg take goal of 250,000. Also, approximately 40,000 fish are transferred to the Whatcom Creek facility.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program may pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Release steelhead yearling smolts in May at a time when the Nooksack River is high and turbid; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 16.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults (Chambers Cr. stock) volunteering into the Kendall Creek Hatchery for broodstock. Steelhead collection and spawning takes place from late December to March while listed Chinook are collected and spawned from April to September. Therefore, winter steelhead broodstock collection is expected to have a limited impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of steelhead for on-station release to a total maximum of 150,000 yearlings at a size of 5 fpp (206 mm fl). All fish reared at McKinnon Ponds on the MF Nooksack River will be trucked back to Kendall Creek Hatchery and released on-station until an adult collection facility is constructed at McKinnon Ponds (HSRG recommendation).

- WDFW shall release steelhead in early May as smolts during high spring glacial runoff to foster rapid migration to salt water and to provide visual protection for listed Chinook salmon juveniles. This helps minimize possible interaction with listed Chinook salmon juveniles (HSRG recommended releasing smolts between May 1 and May 15).

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the scoping and design of a well field and water distribution system (HSRG recommendation).

Table 17. Summary of risk aversion measures for the Kendall Creek Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from wells and Kendall Creek under permits G1-10562c, G1-23261c, G1-23273a, and S1-00317c. Water used in the hatchery is routed to Kendall Creek immediately below the hatchery.
Intake Screening	4.2	Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed species.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1037.
Broodstock Collection & Adult Passage	7.9	Winter steelhead are collected in a time period (late December to March) when spring Chinook are typically not present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation and corresponds to a period of high, turbid flows in the Nooksack River. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>Whatcom Creek Winter Steelhead Program</u>: Winter steelhead are reared at the Whatcom Creek Hatchery through an isolated harvest program with an annual release of approximately 40,000 smolts.. This program releases 5,000 smolts in May into Whatcom Creek and 35,000 into the Samish River in May, at approximately 5 fpp (206 mm fl). Neither Whatcom Creek nor the Samish River have been identified by the PSTRT as Chinook or summer chum populations.

Although it is preferred that the broodstock be taken from adult Whatcom returns, eggs are taken from broodstock returning to Kendall Creek Hatchery, which originated as Chambers Creek stock.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location. Competition or predation impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 17.

Operational Commitments:

- WDFW will continue to propose using gametes from steelhead adults volunteering into the Whatcom Creek Hatchery (Cooperative) for broodstock when sufficient numbers are available. Collection and spawning of steelhead would take place from December through March. No known listed Chinook salmon exist in the watershed. Source of fish for the program when returns are not sufficient will be the Kendall Creek Hatchery.

- WDFW will limit, as the management intent, annual production of steelhead for on-station release to a total maximum of 5,000 steelhead yearlings at a size of 5 fpp (206 mm fl). The remaining 35,000 smolts will be trucked to the Samish River for release.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 18. Summary of risk aversion measures for the Whatcom Creek Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation: Water is obtained from wells and Kendall Creek under permits G1-10562c, G1-23261c, G1-23273a, and S1-00317c. Rearing: No listed species are known to occur in Whatcom Creek.
Intake Screening	4.2	Incubation: Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed species. Rearing: No listed species are known to occur in Whatcom Creek.
Effluent Discharge	4.2	Incubation. Effluent from Kendall Creek Hatchery is regulated through NPDES permit WAG 13-1037. Rearing. No listed species are present within Whatcom Creek. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	Winter steelhead are collected in a time period (late December to March) at Kendall Creek Hatchery when listed spring Chinook are typically not present. No listed species are known to occur in Whatcom Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Release sites occur in watersheds where the Puget Sound Technical Recovery Team has not identified a Chinook salmon population. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Chum Salmon

<u>Whatcom Creek Chum Program</u>: Fall chum salmon are produced at the Whatcom Creek Hatchery through an isolated harvest program that also provides educational benefits to students attending the Bellingham Technical College. In May, students release approximately 2,000,000 fry at a size of 400 fpp (53mm fl). With an egg take goal of 2.2 million, approximately 2,000 adults (1:1; male:female) are taken at the Kendall Creek facility; broodstock collection will be switched to Whatcom Creek Hatchery as the fall chum program at Kendall Creek Hatchery is phased out.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location and species released. Ongoing and proposed risk aversion measures for this program are summarized in Table 18.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of fall chum for on-station release from the Whatcom Creek Hatchery (Cooperative) to a total maximum of 2,000,000. The egg source is from the Kendall Creek facility.

- WDFW will release fall chum at 400 fpp (53 mm fl) in May during high tide at dusk.

Pink Salmon

<u>Whatcom Creek Pink Program</u>: The goal of this program is to produce an egg source to restore several depleted sub-stocks of pink salmon within the Nooksack - Whatcom Creek basin. Broodstock has come from the Middle Fork Nooksack River, but in 2001 sufficient numbers returned to the Whatcom Creek trap for collection. The goal of the program is the release of 1,000,000 pink salmon fry at 500-750 fpp (49-43 mm fl) in March. This will require a broodstock collection level of 2,000 adults (1:1).

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location and species released. Ongoing and proposed risk aversion measures for this program are summarized in Table 19.

Operational Commitments:

- WDFW will continue to use gametes from pink salmon adults volunteering into the Whatcom Creek Hatchery (Cooperative) for broodstock when sufficient numbers are available. Collection and spawning of pink salmon takes place from September through first week of October. No listed species are known to occur in the Whatcom Creek watershed.

- WDFW will limit, as the management intent, annual production of pink salmon for on-station release from the Whatcom Creek Hatchery (Cooperative) to a total maximum of 1,000,000.

- WDFW will release pink salmon in March between 500-750 fpp (49-43 mm fl).

Table 19. Summary of risk aversion measures for the Whatcom Creek Chum program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Spawning: Water is obtained from wells and Kendall Creek under permit permits G1-10562c, G1-23261c, G1-23273a, and S1-00317c . Incubation and Rearing: No listed species are known to occur in Whatcom Creek.
Intake Screening	4.2	Spawning: Kendall Creek upstream of the gravity intake is dry in the summer and contains no listed species. Incubation and Rearing: No listed species are known to occur in Whatcom Creek.
Effluent Discharge	4.2	Spawning: Effluent is regulated through NPDES permit WAG 13-1037. Incubation and Rearing: No listed species are known to occur in Whatcom Creek. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	Fall chum salmon are collected in a time period at Kendall Creek Hatchery when listed spring Chinook are typically not present. No listed species are known to occur in Whatcom Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history and feeding habits of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook and summer chum.

Table 20. Summary of risk aversion measures for the Whatcom Creek Pink program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	No listed species are known to occur in Whatcom Creek.
Intake Screening	4.2	No listed species are known to occur in Whatcom Creek.
Effluent Discharge	4.2	No listed species are known to occur in Whatcom Creek. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	No listed species are known to occur in Whatcom Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history and feeding habits of pink salmon are expected to result in limited competitive and predatory interactions with listed Chinook and summer chum salmon.

Skagit River

Ecological Context for Hatchery Production

At least 23 stocks of eight species of anadromous salmonids occur in the Skagit River Basin. The status of these stocks is mixed. Chinook salmon and bull trout are listed as threatened status under the ESA. The abundance of mainstem Skagit/Tributary steelhead is depressed. Other stocks are healthy or the status is unknown. Hatchery programs occur on seven of these stocks (Table 20) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

Skagit River is the largest river basin in Puget Sound. Several major rivers—the Baker River, Cascade River, Suiattle River, and Sauk River—arise from different parts of the Cascade Mountains and join the main stem that begins in Canada. Although it remains a stronghold for salmon in the Puget Sound, changes in habitat during the last 150 years have greatly reduced the productivity of the system. Major losses of salmon habitat have occurred in the estuary. Historically, vegetated tidal wetlands covered 25,766 acres of the estuary but diking, development, and agriculture have reduced the area to 1,941 acres (Dean et al. 2000). Overall, approximately 72% of the estuary has been lost (Eric Beamer, Skagit System Cooperative, unpublished data). Construction of hydroelectric dams prevented unrestricted access of salmon to the Baker River. Three additional hydroelectric dams occur on upper Skagit River, although the area above these dams may not have been extensively used by anadromous salmonids. Most of the Skagit Basin occurs at intermediate elevations and are dominated by rainfall and snowmelt floods. Increases in mass wasting (landslides) into the river often associated with road construction and timber harvest removes structure from the rivers, fills pools, and scours river beds impeding survival of salmon eggs incubating in the gravel. Nearly half the watersheds in the Skagit Basin have lower than expected egg-to-fry survival of salmon because of impaired flows or sediment. Degraded water quality mainly in the lower Skagit River basin where much of the development and agriculture occurs is also a limiting factor for salmon (Entranco 1993, WDOE 1997).

Marblemount Hatchery, which is owned and operated by WDFW, is the main hatchery in the Skagit River. It is located on the Cascade River and produces spring, summer, and fall Chinook salmon (Skagit origin), coho salmon (a composite of Skagit, Wallace River, and Minter Creek origins), and winter steelhead (introduced Chambers Creek origin). Barnaby Slough is a rearing pond for winter steelhead located downstream of Marblemount Hatchery on the Skagit River near the town of Rockport. Tribal facilities in the Skagit River Basin include the Upper Skagit Tribal Hatchery and the Swinomish Raceways. The Upper Skagit Tribe operates the Upper Skagit Tribal Hatchery on the Upper Skagit Reservation for chum salmon. The Swinomish raceways are located in the Swinomish Channel across from the town of La Conner. The facility is owned by the Swinomish Indian Tribal Community and operated by the Skagit System Cooperative. Puget Sound Energy (PSE) operates a series of artificial spawning beaches for sockeye salmon along Baker Lake as mitigation for hydroelectric dams. Although the focus of this program is to assist natural spawning, the program is supported by a small fish culture facility consisting of circular tanks, four small raceways, starter troughs, a new incubation facility and an asphalt rearing pond. PSE, along with WDFW, operate a coho program that releases fry into Sulphur Creek and yearlings into Baker and Shannon lakes and at the Baker River trap just below the dam.

Table 21. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Skagit River Basin. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Upper Skagit[6]	Threatened[2]	Integrated research
	Lower Skagit[6]	Threatened[2]	Integrated research
	Lower Sauk[6]	Threatened[2]	-
	Upper Sauk[6]	Threatened[2]	-
	Suiattle[6]	Threatened[2]	Integrated research
	Cascade[6]	Threatened[2]	-
Coho salmon	Skagit	Healthy[3]	-
	Marblemount (Clarks Cr.)	NE	Isolated harvest
	Baker	Healthy[3]	Integrated harvest
Chum salmon	Mainstem Skagit fall	Healthy[3]	-
	Sauk fall	Healthy[3]	-
	Lower Skagit tributaries fall	Unknown[3]	-
Pink salmon	Skagit	Healthy[3]	-
Sockeye salmon	Baker	Healthy[3]	Integrated recovery
Steelhead	Finney Creek summer	Unknown[3]	-
	Sauk summer	Unknown[3]	-
	Cascade summer	Unknown[3]	-
	Mainstem Skagit/Tributary winter	Depressed[3]	-
	Marblemount/Barnaby winter	Hatchery	Isolated harvest
	Sauk winter	Unknown[3]	-
	Cascade winter	Unknown[3]	-
Bull trout/ Dolly Varden[1]	Lower Skagit	Healthy[4]	-
	Upper Skagit	Unknown[4]	-
	Baker Lake	Unknown[4]	-
Cutthroat trout	Skagit	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

Marblemount Coho Program: Coho salmon are produced at the Marblemount Hatchery through an integrated harvest program with an annual release of approximately 250,000 smolts at a size of 17 fpp (137 mm fl). The size of the program has been reduced by 41% from the average release for the 1993 and 1994 brood years. Smolts are released on-station in June as a risk aversion measure for listed Chinook juveniles. In addition, the egg-take goal of 650,000 is used to supply other projects, including net pen operations, tribal programs and educational projects. The tribal program consists of 100,000 yearling coho at 25 fpp (121mm fl) released into Indian Slough, in south Padilla Bay.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinookand summer chum salmon populations. A review of the program suggested the following program modifications (in addition to the program reduction from 423,500 to 250,000 yearling smolts effective for the 1994 brood year) as risk aversion measures to address these potential hazards:

1) Delay the release of coho salmon smolts from May until June; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 21.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Marblemount Hatchery for broodstock. Coho collection and spawning takes place from October to January. Fall and summer Chinook are collected on the river while the spring Chinook are collected and spawned at the trap from April to September. Any unmarked Chinook that enter the pond during coho salmon broodstock collection will be returned to the river.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho for Marblemount on-station release to a total maximum of 250,000 yearlings (17 fpp or 137 mm fl).

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interaction with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will apply a double index coded-wire tag group (DIT) to allow for selective fisheries, the evaluation of fishery contribution, overall survival rates and straying levels to other Puget Sound watersheds.

- WDFW will commit funds for the design and construction of a new pollution abatement system (HSRG recommendation).

Table 22. Summary of risk aversion measures for the Marblemount Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water at Marblemount Hatchery is regulated under the following permits: S1-23230c, S1-06773c, S1-06774c, S1-21701c, S1-00419c and S1-20241c. Water used in the hatchery is routed to the creek immediately below the hatchery.
Intake Screening	4.2	Intake screens at Marblemount Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1037.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter an off-channel pond at Marblemount Hatchery from October through January. Spring chinok typically enter from April through September. Any unmarked Chinook that enter the pond during coho salmon broodstock collection will be returned to the river.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Program size reduced by 41% from the average release for the 1993 and 1994 brood years. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Baker Lake Coho Program: For the past ten years (1993-2002), this coho program has planted fry and yearling coho into the Baker River system, a Skagit River tributary (WRIA 3 & 4). Since inception in 1993, the ten year escapement has been 5557 adults of which more than 95% plus have been trapped and hauled up to Baker Lake to spawn naturally. Less than 5%, an average of 242 adults, is utilized to support a fry plant of up to 120,000 fish into Sulpher Creek and a yearling program of 60,000 smolts released in three locations: Baker Lake, Lake Shannon and at the mouth of Baker River. The purpose of this program is to: 1)supply experimental and research smolts for gulper efficiency testing, 2) serve as an indicator stock for wild Skagit coho, and 3) supplement natural production in the basin. All other species, with the exception of Chinook and hatchery steelhead, are hauled into Baker Lake to spawn naturally. The trapping site is on PSE land and is secure. This program provides a research element not available from sockeye due to IHNV.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These hazards are addressed through the risk aversion measures summarized in Table 22.

Operational Commitments:

- Every adult coho will be handled in a dip net and visually inspected and wanded for marks and CWT's. Power crowders are used to transfer the fish. Adults are hauled and placed into circular ponds (at RM 9) or into Baker Lake to spawn naturally.

- The management intent is to limit annual production of coho salmon to a maximum of 60,000 smolts (release locations are Baker Lake, Lake Shannon, and the mouth of the Baker River) at a size of 17 fpp (137 mm fl) and 120,000 fed fry into Sulphur Creek.

- Fish (yearlings) destined for Baker Lake and Lake Shannon are freeze-branded and adipose-fin clipped only. The fish released at the mouth of the Baker River are adipose-fin clipped only. About 25,000–30,000 wild smolts are coded-wire tagged only coming out of Baker Lake. Fed fry released from Sulphur Springs are not marked.

- The fed fry release is in April/May 500-700 fpp (44mm fl) and migrate out of the lake the following June as smolts while the smolts 17 fpp (137mm fl) are released in June.

Table 23. Summary of risk aversion measures for the Baker Lake Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from springs containing no fish.
Intake Screening	4.2	Water is obtained from springs containing no fish.
Effluent Discharge	4.2	No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter the Baker River trap. Unmarked Chinook salmon that enter the trap are handled as follows: fish captured through August 15 are released into Baker Lake; fish captured from August 16 through October 10 are returned to the Skagit River; fish captured after October 10 may be taken to Marblemount Hatchery for use in the fall Chinook research program.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Winter Steelhead

Marblemount Winter Steelhead Program: Winter steelhead are produced at the Marblemount Hatchery through an isolated harvest program with an annual release of approximately 334,000 smolts at a size of 5 ffp (206 mm fl). Fish are released at the following locations: 1) 136,000 on-station; 2) 30,000 at Davis Slough (RM 40); 3) 60,000 at the Baker River Trap; and 4) 108,000at Grandy Creek and Fabors Ferry (RM 68). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Whitehorse Ponds) to increase the likelihood that steelhead smolts released into the Skagit River will rapidly emigrate to marine waters; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 23.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Marblemount Hatchery, the Baker River Trap, or Barnaby Slough for broodstock. Steelhead collection and spawning takes place from late December to March while listed spring, summer and fall Chinook are collected and spawned outside this time frame. Therefore, steelhead broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 334,000 yearlings at a size of 5 fpp (206 mm fl). Fish are released at the following locations: 1) 136,000 on-station; 2) 30,000 at Davis Slough (RM 40); 3) 60,000 at the Baker River Trap; and 4) 108,000 at Grandy Creek and Fabors Ferry (RM 68). No more than 51% of the fish are released above the Rockport Bridge.

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation by winter steelhead smolts (HSRG recommended release between May 1 and May 15). As a risk aversion measure, the winter steelhead will also be released at a time, size, and life history stage (smolted) thatfosters rapid migration to salt water. This helps minimize possible interaction with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the design and construction of a new pollution abatement system (HSRG recommendation).

Table 24. Summary of risk aversion measures for the Marblemount Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water at Marblemount Hatchery is regulated under the following permits: S1-23230c, S1-06773c, S1-06774c, S1-21701c, S1-00419c and S1-20241c. Water used in the hatchery is routed to the creek immediately below the hatchery.
Intake Screening	4.2	Intake screens at Marblemount Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Marblemount Hatchery is regulated under NPDES permite WAG 13-3015.
Broodstock Collection & Adult Passage	7.9	Winter steelhead voluntarily enter an off-channel trap in a time period (late December to March) when Chinook salmon are unlikely to be present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Whitehorse Ponds) rearing location for release in the Skagit River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Barnaby Slough Winter Steelhead Program: Winter steelhead are produced at the Barnaby Slough facility through an isolated harvest program with an annual release of approximately 200,000 smolts at a size of 5 ffp (206 mm fl). Fish are released at the following locations: 1) 136,000 on-station and 2) 64,000 at Grandy Creek and Fabors Ferry (RM 68). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures summarized in Table 24.

Operational Commitments:

- WDFW will continue to use gametes fromsteelhead adults volunteering into the Barnaby Slough facility for broodstock. Steelhead collection and spawning takes place from late December to March when listed Chinook are unlikely to be present.

Therefore, steelhead broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 200,000 yearlings at a size of 5 fpp or 206 mm fl. The hatchery releases up to 136,000 on-station and the remaining 64,000 are acclimated and/or released from sites on the Skagit River below the Rockport bridge (Grandy Creek and Fabors Ferry (RM 68)).

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation by winter steelhead smolts. As a risk aversion measure, the winter steelhead will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interaction with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the design of an acclimation and adult trapping facility at Grandy Creek (HSRG recommendation).

Chum Salmon

Upper Skagit Hatchery & Swinomish Raceways: The purpose of this program is to provide fish for harvest and for education. The production goal is to release 500,000 chum salmon into the Skagit River. Approximately 500 brood stock are collected from the main stem of the Skagit River (river miles 40-44) using drift tangle nets. Eggs are collected and fertilized using a modified factorial mating and incubated at the Upper Skagit Hatchery. Button-up fry are moved into circular tanks for early rearing. Historically, fish were moved to the Swinomish Raceways a month before release for acclimation and final rearing and the fish were released from the Swinomish Raceways in mid to late May when fish had achieved the 0.77 g size. Future releases will be from the Upper Skagit Hatchery.

The effects of this program on Chinook salmon are minimal. Brood stock collection has little negative impact on Chinook salmon. Chinook salmon spawning ends nearly a month before brood stock collection. Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare. The hatchery program does not affect incidental take of Skagit River Chinook salmon (estimated to be eight adult equivalent fish per year) during the chum fishery, because the fishery is managed based on production wild chum populations and not the hatchery production.

Table 25. Summary of risk aversion measures for the Barnaby Slough Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation. Usage of surface water at Marblemount Hatchery is regulated under the following permits: S1-23230c, S1-06773c, S1-06774c, S1-21701c, S1-00419c, S1-20241c. Rearing. Usage of surface water at the Barnaby Slough facility is regulated under permit G1-25483.
Intake Screening	4.2	Incubation. Intake screens at Marblemount Hatchery are believed to be compliant with NOAA fish screening standards. Rearing. Intake facilities are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Incubation. Effluent from the Marblemount Hatchery is regulated under NPDES permit WAG 13-3015. Rearing. Effluent from the Marblemount Hatchery is regulated under NPDES permit WAG 13-3003.
Broodstock Collection & Adult Passage	7.9	Winter steelhead voluntarily enter an off-channel trap in a time period (late December to March) when Chinook salmon are unlikely to be present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Sockeye Salmon

Baker Lake Sockeye Program: The goal of this program is to maintain an adult return of 3,000 fish and to prevent the extirpation of this unique stock by providing a suitable semi-natural spawning/incubation opportunity via man-made spawning channels and/or other fish cultural methods (vertical incubation). There are no specific release goals, but the egg take goal is 2,500,000 (2002 Future Brood Document). With that goal, 1,000,000 are planned to be artificially incubated (500,000 in 2002) with the rest going to the spawning beaches. All fish are released as post-emergent fry into Baker Lake. Release of fish from the artificial incubation facility into Lake Shannon is currently under consideration.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the species released. Ongoing and proposed risk aversion measures for this program are summarized in Table 25.

Operational Commitments:

- WDFW/PSE will continue to collect sockeye at the Baker River trap for broodstock purposes as well as for the spawning beaches. Sockeye are collected between the end of June to the end of August. All unmarked Chinook salmon trapped up to August 15 will be transported to Baker Lake, and those trapped from then until the end of August will be returned to the Skagit River. All Chinook salmon with a CWT will have their CWT's extracted and read at the trap to determine hatchery origin.

Table 26. Summary of risk aversion measures for the Baker Lake Sockeye program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from springs containing no fish.
Intake Screening	4.2	Water is obtained from springs containing no fish.
Effluent Discharge	4.2	No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	Sockeye salmon voluntarily enter the Baker River trap from approximately the end of June through the end of August. Unmarked Chinook salmon that enter the trap are handled as follows: fish captured through August 15 are released into Baker Lake; fish captured from August 16 through October 10 are returned to the Skagit River; fish captured after October 10 may be taken to Marblemount Hatchery for use in the fall Chinook research program.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history and feeding habits of pink salmon are expected to result in limited competitive and predatory interactions with listed Chinook and summer chum salmon.

Stillaguamish River

Ecological Context for Hatchery Production

The Stillaguamish River Basin consists of a large main stem, two main branches (the North and South Forks), and independent tributaries. Over 977 linear miles of river, stream, and tributaries exist in the basin. The main stem formed by these two major streams and independent tributaries once meandered for approximately 18 miles across a broad flood plain before flowing into the Puget Sound. This area contains a variety of channels and sloughs, many of which have been extensively modified by human activities.

At least 14 stocks of seven species of anadromous salmonids occur in the Stillaguamish River basin. The status of these stocks is mixed. Populations of Chinook salmon and steelhead are depressed and Chinook salmon are listed under ESA. Chum and pink salmon and cutthroat trout populations are healthy. Hatchery programs occur on four of these stocks (Table 26) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

Changes in salmon habitat in the Stillaguamish watershed severely constrain natural production of salmonids. Logging began in the watershed in the 1860s and by the 1940s most areas along the river that supported anadromous salmonids had been logged. Compared to historical conditions, the main stem, North Fork, and South Fork of the Stillaguamish River have lost nearly one-third of their side channel habitats—which provided rearing and refuge for coho and Chinook salmon—from construction of dikes and revetments associated with agriculture, roads, and railroads. Only 11% of the riparian forests in the Stillaguamish watershed are in fully functional condition and this combined with removal of wood and increased sedimentation has led to loss of critical pool habitat. Sedimentation resulting from landslides of which 75% are associated with logging activities is a major problem. In addition to filling pools, fall and winter peak stream flows can scour sediments and redeposit them over salmon redds, killing the eggs. In contrast, low stream flows in July through September strand, impede, and increase thermal stress on migrating adult salmon.

Much of the remaining Stillaguamish River estuary and nearshore is in relatively good condition compared to urban areas of the Puget Sound. By the 1970s, however, over 85% of the historical tidal marsh had been converted to agriculture and only a small portion of the historical marsh remained. In recent decades newly formed sand and mudflats have been increasing the overall area of the Stillaguamish delta, but this is of less value for salmon than salt marsh habitat. In the remaining salt marsh, invasion of non-native cordgrasses (*Spartina*) threatens to eliminate the native salt marsh vegetation.

Four state and tribal hatchery facilities occur in the Stillaguamish watershed. WDFW operates two hatchery facilities. Arlington Hatchery is located near the town of Arlington on the North Fork and rears rainbow and cutthroat trout for planting into lowland and alpine lakes. The Whitehorse Springs Rearing ponds are located 1.5 miles from the mouth of Whitehorse Springs Creek at river mile 29 on the North Fork and rears summer and winter steelhead. The Stillaguamish Tribe operates the Harvey Creek Hatchery, which is located on Harvey Creek two miles above the confluence of Harvey Creek and the main stem of the Stillaguamish River at river mile 15, and the Johnson Creek Hatchery, which is located on Johnson Creek 2.5 miles above the confluence of Johnson Creek and the North Fork of the Stillaguamish River.

Table 27. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Stillaguamish River Basin. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	North Fork Stillaguamish[6] Stillaguamish[6]	Threatened[2] Threatened[2]	Integrated recovery -
Coho salmon	Stillaguamish Deer Creek	Healthy[3] Unknown[3]	Integrated harvest -
Chum salmon	North Fork fall South Fork fall	Healthy[3] Healthy[3]	- -
Pink salmon	North Fork South Fork	Healthy[3] Healthy[3]	- -
Steelhead	Deer Creek summer South Fork summer Whitehorse Pond (Skamania) Canyon Creek summer Stillaguamish winter Whitehorse Pond winters	Depressed[3] Depressed[3] NE Unknown[3] Depressed[3] NE	- - Isolated harvest - - Isolated harvest
Bull trout/ Dolly Varden[1]	Stillaguamish	Unknown[4]	- -
Cutthroat trout	Stillaguamish	Healthy[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

Stillaguamish (Harvey and Johnson Creek Hatchery) Coho Salmon: This program is operated by the Stillaguamish Tribe. The purpose of this program is to provide a limited, selective terminal-area fishery for Stillaguamish tribal members during years when natural escapement would not allow a fishery and to establish a single natural origin brood stock for coho salmon restoration with the basin. The production objectives for this program are to release 53,500 yearling coho salmon from 45 pairs of adults collected in late October and November from Fortson Creek, a tributary of the North Fork. Fish are spawned and eggs are incubated at Harvey Creek Hatchery. Fry are reared in Netarts early-rearing troughs for a month before being transferred to 14 foot circular rearing tanks in February and March. Before release from either the Johnson Creek (North Fork) Hatchery or Harvey Creek in early to mid May, coho salmon are exposed to 0.003 mg/liter phenethyl alcohol for imprinting, which is subsequently used to attract returning adults to an isolated terminal area (Triangle Cover) for harvest.

This program attempts to minimize effects on Chinook salmon in a variety of ways. Brood stock collection was designed to have little negative impact on Chinook salmon. Most of the brood stock collection for coho salmon occurs after Chinook salmon have completed spawning and potential take is further reduced by collecting brood stock from Fortson Creek, which does not support a natural spawning aggregatgion of Cinook salmon. Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Although the number of coho salmon released is relatively small compared to many programs, potential competition and predation couldoccur between coho salmon and Chinook salmon during juvenile outmigration because of the overlap in migration timing. Current strategy to reduce these interactions is to hold the fish until they are showing visual signs of smoltification, when physiological changes are most likely to promote rapid outmigration and reduce the time the coho salmon encounter Chinook salmon, and to release the fish at relatively smaller sizes (18-20 fish/pound), which reduces the likely of predation. The program is also considering delaying the release of coho salmon to reduce overlap in outmigration timing. Potential interactions as adults are minimized by using chemical imprinting and attraction to isolated area where wild fish are unlikely to occur.

Steelhead

Whitehorse Pond Winter Steelhead Program: Winter steelhead are produced at the Whitehorse Pond facility through an isolated harvest program with an annual release of approximately 130,000 smolts (110,000 released from the Whitehorse Ponds and 10,000 each into Pilchuck Creek, and Canyon Creek) at a size of 5-8 fpp (206 – 176 mm fl). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Reiter Ponds) to increase the likelihood that steelhead smolts released into the Stillaguamish River will rapidly emigrate to marine waters; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 27.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Whitehorse facility for broodstock. Steelhead collection and spawning takes place from late December to March while summer Chinook are collected from the river and spawned from early August to early September. Therefore, steelhead broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of winter-run steelhead for release to a total maximum of 130,000 yearlings at a size of 5-8 fpp (206-176 mm fl).

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, truck and release from an out-of-basin location (Reiter Ponds) will be eliminated, and winter steelhead will be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. These actions help minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW has secured $300,000 of “Economic Stimulus” funding via the Washington State legislature for upgrading water supplies and infrastructure at Whitehorse for better rearing environment. Implementation is currently underway (HSRG recommendation).

Table 28. Summary of risk aversion measures for the Whitehorse Pond Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from spring water certificate (S1-*00825cwris) and subsequently routed into the Stillaguamish River. No listed species are present in the water source.
Intake Screening	4.2	No listed species are present in the water source.
Effluent Discharge	4.2	Effluent from Whitehorse Pond is regulated through NPDES permit 13-3008.
Broodstock Collection & Adult Passage	7.9	Winter steelhead voluntarily enter an off-channel pond in a time period (October through early December) when spring Chinook are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager’s Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Reiter Ponds) rearing location for release in the Stillaguamish River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelheadsmolts.

Whitehorse Pond Summer Steelhead Program: Summer steelhead are reared at the Whitehorse Pond facility through an isolated harvest program with an annual release of approximately 110,000 smolts (70,000 released from the Whitehorse Ponds; 15,000 into the South Fork Stillaguamish at Silverton; 15,000 into the South Fork Stillaguamish at Red Bridge; and 10,000 into Canyon Creek). Broodstock collection and incubation to the eyed egg stage occurs at Reiter Ponds. Eyed eggs are transferred to Arlington Hatchery and reared to a size of 100 fpp before transfer to Whitehorse Pond for final rearing to a size of 6 fpp (194 mm fl). Smolts are released in mid-May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predationand competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Reiter Ponds) to increase the likelihood that steelhead smolts released into the Stillaguamish River will rapidly emigrate to marine waters;; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 28.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of summer-run steelhead for release from the Whitehorse Pond to a total maximum of 110,000 smolts (70,000 released from the Whitehorse Ponds; 15,000 into the South Fork Stillaguamish at Silverton; 15,000 into the South Fork Stillaguamish at Red Bridge) at a size of 6 fpp (194 mm fl).

- WDFW will release summer steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, truck and release from an out-of-basin location (Reiter Ponds) will be eliminated, and summer steelhead will be released at a time, size, and life history stage (smolted) thatfosters rapid migration to salt water. These actions help minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW has secured $300,000 of “Economic Stimulus” funding via the Washington State legislature for upgrading water supplies and infrastructure at Whitehorse for better rearing environment. Implementation is currently underway (HSRG recommendation).

Table 29. Summary of risk aversion measures for the Whitehorse Pond Summer Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation. Water is obtained from springs at Reiter Ponds, certificate S1-00667cwris, and subsequently routed into the Skykomish River. Rearing. Water at Arlington Hatchery is obtained under permit S1-*05004cwris. . Rearing. Water is obtained from springs (certificate S1-*00825cwris) at Whitehorse Hatchery and subsequently routed into the Stillaguamish River. No listed species are present in any of the water sources.
Intake Screening	4.2	No listed species are present in any of the water sources.
Effluent Discharge	4.2	Incubation. Effluent from Reiter Ponds is regulated through NPDES permit WAG 13-3006. Incubation and Rearing. Effluent from the Arlington Hatchery is regulated through NPDES permit WAG 13-3008. Rearing. Effluent from the Whitehorse Hatchery is regulated through NPDES permit WAG 13-3008.
Broodstock Collection & Adult Passage	7.9	Summer steelhead voluntarily enter the Reiter Pond trap which is operated from June 1 through January 31 of each year. Any listed Chinook salmon that enter the trap will be returned to the Skykomish River.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Reiter Ponds) rearing location for release in the Stillaguamish River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Chum Salmon

Stillaguamish (Harvey Creek Hatchery) Fall Chum: This program is operated by the Stillaguamish Tribe. The purpose of this program is to develop a native brood stock that is used in school programs that teach students about salmon life history, habitat, and hatchery activities. The production objectives of this program are to release 200,000 chum salmon from 300 brood stock collected from adults returning to Harvey Creek Hatchery from late October through early January. This hatchery chum salmon run was established from wild fish from Squire Creek, Ashton Creek, and Jim Creek (a combination of North and South Fork stocks) during 1978-1982. Harvey Creek was not historically used by North Fork chum salmon. Fish are spawned and eggs are incubated at Harvey Creek Hatchery. Fry are transferred to 20 circular tanks for rearing in February and March. Fish are released from Harvey Creek from April to mid May at approximately 400 fpp (52mm fl).

The effects of this program on Chinook salmon are minimal. Brood stock collection has little negative impact on Chinook salmon. Chinook salmon do not return to Harvey Creek where chum salmon brood stock are collected. No Chinook salmon have ever been captured in the collection trap during the 20 years this program has been operating. Potential disease effects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition could occur between juvenile Chinook salmon and chum salmon, because they have overlapping outmigration timing. To reduce potential competition, the program has been reduced from 600,000 to 200,000 fish released annually. In addition, most chum salmon releases occur prior to the peak outmigration time for Chinook salmon, and these releases are staggered over a month to avoid large concentrations of fry outmigrating in the river at any given time. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare.

Snohomish River

Ecological Context for Hatchery Production

The Snohomish River Basin includes the Snohomish River, its two principal branches, the Skykomish and Snoqualmie Rivers. It encompasses 1,780 square miles of which the Skykomish and Snoqualmie watersheds contribute 844 and 693 square miles respectively. Small, independent streams flowing into Possession Sound and Tulalip Bay are often included in this region, but we discuss the hatchery programs in those areas as part of the overall set of programs in independent bays and tributaries of Mid-Puget Sound.

The Snohomish River and its tributaries continue to support much of the natural production of salmonids in the Puget Sound. At least 19 stocks of seven species of anadromous salmonids occur in the Snohomish River basin. The status of these stocks is mixed. Currently, listed Chinook salmon populations from the Snohomish basin (Skykomish and Snoqualmie Rivers) are above critical thresholds, however, these populations are at levels substantially below the Co-managers' recovery goals. Coho, chum, and pink salmon, bull trout, and cutthroat trout populations are healthy. Hatchery programs are implemented on five stocks for three species (Chinook, coho, and steelhead) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by natural production.

Although the Snohomish River is a mainstay of natural production in the Puget Sound, changes in habitat have led to declines in abundance and diversity of many species. One of the most important changes has been the loss of floodplain and intertidal wetlands, which are criticaly important to many anadromous salmonids. Development and agriculture have led to at least a 74% reduction in floodplain wetlands and a 32% reduction in intertidal wetlands (Bortelson et al 1980), leading to a reduction in coho and Chinook salmon production capacity of 40-61% (Haas and Collins 2001). In addition, channel condition and complexity has been altered anthropogenic induced changes. These changes along with removal of the riparian forest and instream large woody debris, bridge construction, and bank-hardening have led to channelization and additional alterations such as in changes in mainstem width and depth. As in many Puget Sound streams, riparian function and access to spawning and rearing areas has been lost due to construction of dikes, levees, and roads. Loss of pool habitat and high water temperatures from these modifications are a major problem for salmon in the main stem of the river.

The WDFW operates the Wallace River Hatchery and associated rearing and release ponds. The main hatchery is located on river mile (RM) 4 of the Wallace River at its confluence with May Creek, which is near to the town of Startup, Washington. The Wallace River is a tributary to the Skykomish River at RM 35.7, and the Skykomish is a tributary to the Snohomish River at RM 21.4.

The Wallace River Hatchery has historically produced Chinook, coho, chum, and pink salmon and steelhead. Currently, the hatchery produces Skykomish River Chinook and coho salmon and is used for rearing Skykomish River summer and winter steelhead for release into the Snohomish basin. Small numbers of cutthroat trout are also reared at the Wallace River Hatchery for lake out-planting outside of the basin. The Reiter Rearing Ponds are located on the Skykomish River at RM 46 and consist of two, 2-acre ponds, incubation facilities, and migrant fish traps. It is used to rear summer and winter steelhead. Tokul Creek Hatchery is located upstream from the confluence of Tokul Creek and the Snoqualmie River at RM 39. This facility is used to rear Skykomish River steelhead and cutthroat trout, although only winter steelhead are released into the Snohomish basin.

Table 30. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Snohomish River Basin. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Snoqualmie[6] Skykomish[6]	Threatened[2] Threatened[2]	- Integrated harvest
Coho salmon	Snohomish Skykomish Wallace River South Fork Skykomish Snoqualmie	Healthy[3] Healthy[3] Hatchery Healthy[3] Healthy[3]	- Integrated harvest Integrated harvest -
Chum salmon	Skykomish fall Snoqualmie fall Wallace fall	Healthy[3] Unknown[3] Healthy[3]	- - -
Pink salmon	Snohomish odd-year Snohomish even-year	Healthy[3] Healthy[3]	- -
Steelhead	Tolt summer North Fork Skykomish summer Reiter Pond summer South Fork Skykomish summer Snohomish/Skykomish winter Wallace R./Reiter Pond winter Pilchuck winter Snoqualmie winter Tokul Cr. winter	Healthy[3] Unknown[3] Hatchery Healthy[3] Depressed[3] Hatchery Depressed[3] Depressed[3] Hatchery	- - Isolated harvest - - Isolated harvest - - Isolated harvest
Bull trout/ Dolly Varden[1]	Skykomish	Healthy[4]	- -
Cutthroat trout	Snohomish	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

Wallace River Coho Program: Coho salmon are produced at the Wallace River Hatchery Hatchery through an integrated harvest program with an annual release of approximately 150,000 smolts at a size of 17 fpp (137 mm fl). Smolts are released on-station in May as a risk aversion measure for listed Chinook juveniles. To also reduce risk to listed Chinook salmon, yearling coho salmom releases have been reduced 50% from the 1993-1998 brood year release levels of 300,000. The Wallace River Hatchery also provides 1,300,000 eggs to the Tulalip tribal coho program, and if sufficient surplus is available, it provides 1,250,000 eggs/fish for the Squaxin/South Sound net pen program and eggs/fish for numerous co-op and educational projects in the Snohomish basin. The 1,300,000 egg transfer goal to the Tulalip program is being reviewed and may increase to 1,600,000 to meet the yearling release goals (Releases at Tulalip Hatchery are not expected to exceed the current goal). Egg-take goal is 4,280,000 with a broodstock collection of approximately 3,200 adults (1:1).

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Reduce program size by 50% from the 1993 through 1998 brood year level of approximately 300,000; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 30.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Wallace River Hatchery for broodstock. Coho collection and spawning takes place from October to December while summer Chinook return between June and August. Therefore, coho salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 150,000 yearlings at a size of 17 fpp (137 mm fl). The release numbers have been reduced by 50% from the 1993 through 1998 release level of 300,000.

- WDFW will release coho salmon in May to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will apply 45,000 CWT/Ad tags and 45,000 CWT-only double index coded-wire tag group (DIT) to allow for evaluation of fishery contribution, overall survival rates, selective fisheries and straying levels.

- WDFW will commit funds for the design of and construction of an upgraded pollution abatement pond (HSRG recommendation).

Table 31. Summary of risk aversion measures for the Wallace River Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from the Wallace River and May Creek is regulated under permits 1899, S1-00108, and S1-00109. Water used in the hatchery is routed to the river immediately below the hatchery.
Intake Screening	4.2	Intake screens on May Creek and the Wallace River are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Wallace River Hatchery is regulated through NPDES permit WAG 13-3006.
Broodstock Collection & Adult Passage	7.9	Coho salmon broodstock are collected in a time period (October to December) when summer Chinook are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Program size reduced by 50% from the 1993 through 1998 brood year release level. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Steelhead

Wallace River Winter Steelhead Program: Winter steelhead are produced at the Wallace River Hatchery through an isolated harvest program with an annual release of approximately 20,000 smolts at a size of 6 fpp (194 mm fl). Broodstock collection and initial rearing (to a size of 100 fpp) occurs at the Tokul Creek Hatchery. Smolts are released on-station in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Whitehorse Ponds) to increase the likelihood that steelhead smolts released into the Snohomish River will rapidly emigrate to marine waters; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 31.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of winter steelhead for release from the Wallace River Hatchery to a maximum of 20,000 yearlings at a size of 6 fpp (194 mm fl).

- WDFW will release summer steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May 1 and May 15). As a risk aversion measure, truck and release from an out-of-basin location (Whitehorse Ponds) will be eliminated, and winter steelhead will be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. These actions help minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the design of and construction of an upgraded pollution abatement pond (HSRG recommendation).

Table 32. Summary of risk aversion measures for the Wallace River Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of spring water and surface water from Tokul Creek is regulated under certificate S1-08944crwis. Rearing. Usage of surface water from the Wallace River and May Creek is regulated under permits 1899, S1-00108, and S1-00109.
Intake Screening	4.2	Incubation and Rearing. A temporary screen has been installed at the Tokul Creek Hatchery that is believed to be compliant with NOAA fish screening standards. Rearing. Intake screens on May Creek and the Wallace River are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from Tokul Creek Hatchery is regulated through NPDES permit WAG 13-3004. Rearing. Effluent from Wallace River Hatchery is regulated through NPDES permit WAG 13-3006.
Broodstock Collection & Adult Passage	7.9	The intake dam poses a barrier to upstream migration of listed adult Chinook (in the fall). Beginning in the fall of 2000, non-adipose fin clipped adults were passed upstream around the barrier manually. The Army Corps of Engineers budget and the Washington 03-05 biennial budget include funding for removal of the hatchery intake dam.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Whitehorse Ponds) rearing location for release in the Snohomish River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

<u>Reiter Pond Winter Steelhead Program:</u> Winter steelhead are reared at the Reiter Pond facility through an isolated harvest program with an annual release of approximately 250,000 smolts (165,000 released on-station; 15,000 at Index; 30,000 in the Sultan River; 15,000 at Monroe; and 25,000 into the Pilchuck River). Broodstock collection and rearing to a size of 100 fpp occurs at Tokul Creek Hatchery. The fingerlings are then transferred to Wallace River Hatchery and reared to a size of 70 fpp before transfer to Reiter Pond for final rearing to a size of 6 fpp (194 mm fl). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Whitehorse Ponds) to increase the likelihood that steelhead smolts released into the Snohomish River will rapidly emigrate to marine waters; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 32.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 250,000 yearlings at a size of 6 fpp (194 mm fl). The facility releases approximately 165,000 on-station while 60,000 are to be acclimated/planted at sites in the Skykomish River watershed (15,000 at Index; 30,000 in the Sultan River; 15,000 at Monroe) and 25,000 are released in the Pilchuck River (tributary to the Snohomish River).

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May 1 and May 15). As a risk aversion measure, truck and release from an out-of-basin location (Whitehorse Ponds) will be eliminated, and winter steelhead will be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. These actions help minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 33. Summary of risk aversion measures for the Reiter Pond Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of spring water and from Tokul Creek is regulated under permit S1-08944crwis. Rearing. Usage of surface water from the Wallace River and May Creek is regulated under permits 1899, S1-00108, and S1-00109. Rearing. Water is obtained from springs certificate G1-00329c and subsequently routed into river.
Intake Screening	4.2	Incubation and Rearing. A temporary screen has been installed at the Tokul Creek Hatchery that is believed to be compliant with NOAA fish screening standards. Rearing. Intake screens on May Creek and the Wallace River are believed to be compliant with NOAA fish screening standards. Rearing. No listed species of salmonids are present within the water source for Reiter Ponds.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from Tokul Creek Hatchery is regulated through NPDES permit WAG 13-3004. Rearing. Effluent from Wallace River Hatchery is regulated through NPDES permit WAG 13-3006. Rearing. Effluent from Reiter Pond is regulated through NPDES permit WAG 13-3005.
Broodstock Collection & Adult Passage	7.9	The intake dam at Tokul Creek poses a barrier to upstream migration of listed adult Chinook (in the fall). Beginning in the fall of 2000, non-adipose fin clipped adults were passed upstream around the barrier manually. The Army Corps of Engineers budget and the Washington 03-05 biennial budget include funding for removal of the hatchery intake dam.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Whitehorse Ponds) rearing location for release in the Snohomish River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Reiter Pond Summer Steelhead Program: Summer steelhead are produced at the Reiter Pond facility through an isolated harvest program with an annual release of approximately 210,000 smolts (150,000 released on-station; 10,000 in the Sultan River, 50,000 in the Raging River). Broodstock collection and incubation to the eyed egg stage occurs at Reiter Ponds. Eyed eggs are transferred to Wallace River Hatchery and reared to a size of 70 fpp (86mm fl) before transfer back to Reiter for final rearing to a size of 6 fpp (194 mm fl). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures summarized in Table 33.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Reiter facility for broodstock. Steelhead collection and spawning takes place from June to January. No listed Chinook salmon have been seen during the collection period at Reiter Pond.

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 210,000 yearlings (150,000 released on-station; 10,000 in the Sultan River, 50,000 in the Raging River) at a size of 6 fpp (194 mm fl).

- WDFW will release summer steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May 1 and May 15). As a risk aversion measure, the summer steelhead yearling smolts will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 34. Summary of risk aversion measures for the Reiter Pond Summer Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of surface water from the Wallace River and May Creek is regulated under permits 1899, S1-00108, and S1-00109. Incubation and Rearing. Water for Reiter Ponds is obtained from springs (certificate S1-00667cwris) and subsequently routed into the Skykomish River.
Intake Screening	4.2	Incubation and Rearing. Intake screens on May Creek and the Wallace River are believed to be compliant with NOAA fish screening standards. Incubation and Rearing. No listed species of salmonids are present within the water source for Reiter Ponds.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from the Wallace River Hatchery is regulated through NPDES permit WAG 13-3006. Incubation and Rearing. Effluent from Reiter Pond is regulated through NPDES permit WAG 13-3005.
Broodstock Collection & Adult Passage	7.9	Summer steelhead voluntarily enter the Reiter Pond trap which is operated from June 1 through January 31 of each year. No listed Chinook salmon have been observed at the trap during the collection period. Any listed Chinook salmon that enter the trap will be returned to the river.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Tokul Creek Winter Steelhead Program: Winter steelhead are produced at the Tokul Creek Hatchery through an isolated harvest program with an annual release of approximately 185,000 smolts at a size of 6 fpp (194 mm fl). Smolts are released in May as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate trucking of smolts from an out-of-basin rearing location (Whitehorse Ponds) to increase the likelihood that steelhead smolts released into the Snohomish River will rapidly emigrate to marine waters; and;
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 34.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Tokul Creek facility for broodstock. Steelhead collection and spawning takes place from late November to late February/early March. Chinook salmon arrival takes place from September to mid-November. All unmarkd Chinook salmon are released upstream of the hatchery.

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 185,000 yearlings at a size of 6 fpp (194 mm fl). These releases occur on station and at acclimation/planting sites in the Snoqualmie River system.

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, truck and release from an out-of-basin location (Whitehorse Ponds) will be eliminated, and winter steelhead will be released at a time, size, and life history stage (smolted) thatfosters rapid migration to salt water. These actions help minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns

Table 35. Summary of risk aversion measures for the Tokul Creek Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring water and surface water from Tokul Creek is regulated under certificate S1-08944crwis.
Intake Screening	4.2	A temporary screen has been installed that is believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from theTokul Creek Hatchery is regulated through NPDES permit WAG 13-3004.
Broodstock Collection & Adult Passage	7.9	The intake dam at Tokul Creek poses a barrier to upstream migration of listed adult Chinook (in the fall). Beginning in the fall of 2000, non-adipose fin clipped adults were passed upstream around the barrier manually. The Army Corps of Engineers budget and the Washington 03-05 biennial budget include funding for removal of the hatchery intake dam.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Trucking of smolts from an out-of-basin (Whitehorse Ponds) rearing location for release in the Snohomish River basin will be eliminated. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Independent Bays and Tributaries

Ecological Context for Hatchery Production

This section covers the independent streams and bays of the north Puget Sound and Island County, except for the San Juan Islands, which were described earlier. Independent streams in these areas may provide limited natural production for the populations associated with nearby major river systems of the Nooksack, Skagit, Stillaguamish, and Snohomish rivers (Tables 13, 20, 26, and 29). Other stocks are the Whidbey Island coho salmon of unknown origin and status that enter Maxwelton Creek (WDFW et al. 1993), Tulalip chum salmon—an introduced, 100% genetically marked hatchery stock—and undescribed stocks of coastal cutthroat trout on Whidbey and Camano islands.

Although these areas are not major freshwater producers of salmon, the estuarine and nearshore marine areas provide important rearing and migratory habitat for many different stocks and species from nearby major rivers. Many of the estuaries and salt marshes that support salmonids in this area have been heavily modified by agriculture, residential, and other land uses. Bulkheads built to protect real estate properties, docks, and marinas have altered habitat and impaired water quality.

A variety of hatchery facilities exist in this area. WDFW operates four net pens at Oak Harbor, Mukilteo, Possession Point, and the Port of Edmonds. The Oak Harbor Net Pen is at Oak Harbor Marina on the eastern shore of Whidbey Island. The Mukilteo Net Pen is located at the Port of Everett Marina in Port Gardner. Possession Point Net Pens is a salt water rearing pond located in Clinton, Washington (Whidbey Island) off of Franklin Road. Laebugten coho net pen is located at the Port of Edmonds near the public fishing pier. The Tulalip Tribes operate the Bernie Kai-Kai Gobin Salmon Hatchery and Tulalip Creek and Battle Creek rearing ponds on the Tulalip Indian Reservation at Tulalip Bay for final rearing, acclimation, and release of coho, Chinook, and chum salmon.

Coho Salmon

<u>Tulalip Bay Coho Salmon</u>: The purpose of this program is to provide coho salmon for harvest by Tulalip tribal members in a terminal area fishery in Tulalip Bay. The program is operated by the Tulalip Tribes. The production objective of this program is to release 1,000,000 yearling coho salmon from eggs and milt collected at the WDFW Wallace River Hatchery. Eggs and milt are collected from Skykomish River coho salmon because no self-sustaining coho salmon stocks occur in Tulalip Bay. Gametes are fertilized and incubated at the Bernie Kai-Kai Gobin Salmon Hatchery. Hatchery fry are transferred to small outdoor races until they have reached approximately 400 fish/pound. They are then transferred to two asphalt rearing ponds until early October when a portion of the production is adipose fin-clipped (a minimum of 250,000) and coded-wire tagged (a minimum of 50,000) each fall. After marking, they are ransported toupper Tulalip Creek pond, a large earthen pond with natural rearing conditions. In late May, the fish are allowed to enter the lower Tulalip Creek pond from which they are released into Tulalip Bay on an incoming tide. Upon return as adult fish, as close to 100% of the fish are harvested in Tulalip Bay as possible to avoid fish straying into other populations and to maximize benefits to tribal members. Actual harvest rates have been between 84-98%.

The effects of this program on listed Chinook salmon are minimal and would only occur after the coho salmon have entered common marine waters with many other stocks. The basic strategy of this program is to isolate coho salmon production and harvest from listed populations of Chinook salmon. No natural, listed populations of Chinook salmon occur in Tulalip Bay. The program does not impact Chinook salmon by brood stock collection because it does not collect its own brood stock (see Wallace River coho program for brood stock descriptions). Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition and predation on non-listed hatchery Chinook salmon also produced by the Tulalip Tribes could occur in Tulalip Bay after release, but the release into a bay with no natural population minimizes interactions with listed natural populations. As a measure to minimize the risk of predation on natural, listed juvenile Chinook salmon in estuarine and nearshore marine waters, the coho release into Tulalip Bay is timed to occur after the third week in May each year, based on comparative size and outmigrant timing data acquired from smolt trapping, fyke netting, and seining studies in the Snohomish River and estuary. The data indicate that juvenile Chinook outmigrants from the Snohomish estuary have attained a larger size toward the end of May, making them less susceptible to predation by coho salmon released by the program.

<u>Coho Salmon Net Pens and Marine Pond</u>. Coho salmon are produced from cooperative programs at net pens located at Oak Habor, Mukilteo, and Possession Point. These isolated harvest programs have a total annual release of approximately 105,000 smolts (30,000 Oak Harbor; 25,000 Mukilteo; 50,000 Possession Point) at a size of 12 to 17 fpp (154 to 137 mm fl). Broodstock collection and initial rearing occurs either at the Marblemount Hatchery of the Wallace River Hatchery. Smolts are released in June directly into marine waters as a risk aversion measure for listed Chinook juveniles.

Summary of Program Evaluation and Risk Aversion Measures: These programs pose minimal risks to listed salmonids because of the release location. Competition or predations impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 35.

Operational Commitments:

<u>Oak Harbor Coho Salmon Net Pen</u>

- WDFW will limit, as the management intent, annual production of coho for release from a net pen in Oak Harbor Marina on Whidbey Island to a total maximum of 30,000 yearlings at a size of 12 fpp (154 mm fl). Fish for the net pens come from the Marblemount Hatchery (Skagit River).

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, life history stage (smolted), and location that minimizes possible interactions with listed Chinook salmon juveniles in fresh and estuarine waters.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

<u>Mukilteo Coho Salmon Net Pen</u>

- WDFW will limit, as the management intent, annual production of coho for release from a net pen at the Port of Everett Marina in Port Gardner Bay to a total maximum of

25,000 yearlings at a size of 15 fpp (143 mm fl). Fish for the net pens come from the Wallace River Hatchery.

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, life history stage (smolted), and location that minimizes possible interactions with listed Chinook salmon juveniles in fresh and estuarine waters.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Possession Point Coho Salmon Pond

- WDFW will limit, as the management intent, annual production of coho for release from the salt water rearing pond located in Clinton, Washington (Whidbey Island) to a total maximum of 50,000 yearlings at a size of 17 fpp (137 mm fl). Fish for the pond come from the Wallace River Hatchery.

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, life history stage (smolted), and location that minimizes possible interactions with listed Chinook salmon juveniles in fresh and estuarine waters.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the pond to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Chum Salmon

Tulalip Bay Chum Salmon: The purpose of this program is to provide chum salmon for harvest by Tulalip tribal members in a terminal area fishery in Tulalip Bay. The program is operated by the Tulalip Tribes. The production objective of this program is to release 8,000,000 chum salmon from brood stock returning to Battle Creek on the Tulalip Indian Reservation. The hatchery program began in 1976 from chum salmon introduced from US Fish and Wildlife facility at Walcott Slough. In 1990-1993, the brood stock was genetically marked in a cooperative project between the tribe and WDFW at two allozyme loci to distinguish it from other nearby natural stocks to be able to assess contribution to fisheries and natural production.

Fish return to the Battle Creek facility on Tulalip Bay where broodstock are collected; their gametes are subsequently spawned and eggs incubated at the Bernie Kai-Kai Gobin Salmon Hatchery. Eyed eggs are placed on screens in outdoor raceways for hatching, emergence, and initiation of feeding. Fed fry are then transferred to two asphalt hatchery ponds for additional rearing. When they reach a size of approximately 700 fish/pound each spring, they are transferred to Battle Creek pond, a large, earthen pond that supports natural rearing conditions. Final rearing occurs in the Battle Creek pond for approximately three weeks before the fry are released into Tulalip Bay in late-April each spring at a size of approximately 375 fpp.

The effects of this program on listed populations of Chinook salmon are minimal. Brood stock collection has little negative impact on Chinook salmon. No natural, listed populations of Chinook salmon occur in Tulalip Bay. Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Release of migrating chum salmon directly into Tulalip Bay eliminates any competition or predation from or on other species in freshwater. Releasing chum salmon well before the releases of non-listed Chinook salmon reduces competition in the nearshore environment. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare.

Table 36. Summary of risk aversion measures for the Oak Harbor, Mukilteo, and Possession Point Net Pen programs.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Marblemount Hatchery. Usage of surface water at Marblemount Hatchery is regulated under the following permits: S1-23230c, S1-06773c, S1-06774c, S1-21701c, S1-00419c, S1-20241c. Wallace River Hatchery. Usage of surface water from the Wallace River and May Creek is regulated under permits 1899, S1-00108, and S1-00109.
Intake Screening	4.2	Marblemount Hatchery. Intake screens are believed to be compliant with NOAA fish screening standards. Wallace River Hatchery. Intake screens on May Creek and the Wallace River are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Marblemount Hatchery is regulated through NPDES permit WAG 13-3015. Effluent from the Wallace River Hatchery is regulated through NPDES permit WAG 13-3006.
Broodstock Collection & Adult Passage	7.9	Marblemount Hatchery. Coho salmon voluntarily enter an off-channel pond at Marblemount Hatchery from October through January. Spring chinok typically enter from April through September. Any unmarked Chinook that enter the pond during coho salmon broodstock collection will be returned to the river. Wallace River Hatchery. Coho salmon broodstock are collected in a time period (October to December) when summer Chinook are not typically present.
Disease Transmission	7.9, 10.11	These programs are operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, life-history stage (smolts), and location to minimize competition in fresh and estuarine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Mid-Puget Sound Region

For the purposes of this plan, the Mid-Puget Sound region covers the marine waters from the southern end of Whidbey Island south to Vashon Island. The geography consists of two major watersheds: Lake Washington and the Duwamish/Green River systems. They currently enter the Puget Sound independently, but prior to 1900 they both flowed into the Duwamish River before flowing into Elliot Bay. In addition this region covers the numerous independent tributaries draining the northeastern portion of the Kitsap Peninsula. Naturally low flow stream discharges during summer months and limited spawning and rearing areas preclude self-sustaining Chinook populations within these smaller independent systems.

Lake Washington, Sammamish, and Cedar Rivers

Ecological Context for Hatchery Production
The Lake Washington watershed (WRIA 8) includes Lake Washington and its tributaries; Lake Sammamish, the Sammamish River and its tributaries; and the Cedar River. The basin includes 470 identified streams and nearly 700 linear stream miles. Only 170 stream miles are currently accessible to anadromous salmonids. Most of these flow through highly urbanized areas of the Seattle metropolitan area where habitat and flow modifications have greatly reduced potential for natural production.

This area includes at least 10 stocks of six species of anadromous salmonids. The status of most of the stocks is depressed, critical, or unknown (Table 36). Hatchery programs occur on 3 of these stocks (Table 36) and are primarily focused on providing harvest that cannot be supported by the natural population.

Although this area was once part of one of the most complex, productive drainages in Puget Sound, urban and commercial development of Seattle and its suburbs has dramatically altered salmon habitat and potential. One of the first and most significant alterations was the construction of the Lake Washington Ship Canal in 1910-1920, which redirected and channelized major tributaries of the Duwamish River, drained a vast wetland complex, and removed the natural estuary. Urban development, dredging, construction of levees, and flood control programs led to the loss of riparian areas, dramatically reducing flows in early summer and fall. In Lake Union and the ship canal, dredging, filling, and hardening of banks have eliminated salmon habitat. Urban and shipping discharges into the river have contaminated bottom sediments. Along Lake Washington, dredging, filling, and construction of bulkheads associated with the growth of 13 cities have shrunk the "natural" shoreline to less than 5% of its historical amount. In the lake, non-native fishes (24 species), plants (9 species), and invertebrates compete with salmon and the historical flora and fauna that supported anadromous populations of salmonids.

The lowering of Lake Washington after the construction of the ship canal began changes in the Sammamish River and tributaries that currently limit natural production of salmonids in this area. The backwaters of Lake Washington no longer extend as far and channelization and ditching needed for farming and development left the Sammamish River one-half its original length and without the extensive wetlands, side channels, and springs that once provided forage areas and refuge for salmon. The river corridor was logged from 1870s through the early 20th Century, vastly reducing riparian areas and increasing water temperatures. Pool habitat has been reduced to a few deep pools. In many of the tributaries known and unknown blockages limit access of fish to spawning areas.

Table 37. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Lake Washington and Sammamish watersheds. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Sammamish[6]	Threatened[2]	-
	Issaquah Creek	NE	Isolated harvest
	Cedar[6]	Threatened[2]	-
Coho salmon	Lake Washington/Sammamish	Depressed[3]	-
	Issaquah Creek	NE	Isolated harvest
	Cedar River	Depressed[3]	-
	University of Washington	NE	Isolated harvest
Sockeye salmon	Lake Washington/Sammamish Tribs.	Healthy[3]	-
	Lake Washington Beach Spawners	Depressed[3]	-
	Cedar River	Depressed[3]	Integrated harvest
Steelhead	Lake Washington winter	Critical[3]	-
Bull trout/ Dolly Varden[1]	Chester Morse Lake	Unknown[4]	-
Cutthroat trout	Lake Washington (unidentified stock)	Unknown	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

A variety of hatchery facilities occur in this area. WDFW operates two hatcheries and a net pen program. Issaquah Hatchery is located on Issaquah Creek, a tributary to the Sammamish River at RM 3 in the town of Issaquah. It produces Chinook and coho salmon for harvest augmentation and eggs for cooperative programs. The Cedar River Hatchery is located at the Landsburg Dam on the Cedar River at river mile 22 with a weir at RM 6 for collecting brood stock. It produces sockeye salmon. WDFW's Ballard coho salmon net pens are located in Shilshole Bay. The University of Washington operates a research oriented facility on Portage Bay in Lake Washington.

Coho Salmon

Issaquah Coho Program: Coho salmon are produced at the Issaquah Hatchery through an isolated harvest program with an annual release of approximately 450,000 smolts at a size of 17 fpp (137 mm fl). Past production also included the rearing and release of 1.0 million fed fry. However, that operation was terminated in 1996. Issaquah Hatchery also transfers over a million eggs/fish for various volunteer co-op and educational projects. The total egg take goal is currently 1,400,000 with a broodstock collection goal being 1,000-2,000 adults (1:1) depending on fecundity.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures, including the release of 1.0 million fed fry, summarized in Table 37.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Issaquah Creek Hatchery for broodstock. Coho collection and spawning takes place from October to mid-November. Any unmarked Chinook salmon captured during broodstock collection will be returned to Issaquah Creek.

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 450,000 yearlings at a size of 17 fpp (137mm fl). Since 1996, 1,000,000 fed fry are no longer planted into Lake Washington tributaries.

- As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 38. Summary of risk aversion measures for the Issaquah Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water may be obtained either from a gravity intake located ¾ mile upstream on Issaquah Creek or five pumps. Usage of surface water from Issaquah Creek is regulated under permits S1-04730c, S1-20582c, and S1-22667a. Water used in the hatchery is routed to Issaquah Creek immediately below the hatchery.
Intake Screening	4.2	The upper intake screens may not meet NMFS screening guidelines. WDFW and the Corp of Engineers are developing plans, under the COE 206 Habitat Restoration Authority, to replace and/or remodel the intake structure to bring it into full compliance for adult and juvenile passage. The lower intake screens are believed to meet NOAA fish passage standards.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-3010.
Broodstock Collection	7.9	A weir and a bar rack at the mouth of the by-pass fish ladder prevent fish from going upstream when trapping. Trapping begins at the end of August for hatchery-origin Chinook salmon and ends in the middle of November. Any unmarked Chinook salmon are returned to Issaquah Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Previous program component of 1.0 million fed fry size eliminated in 1996. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Portage Bay (UW) Coho Program: Coho salmon are produced at the Portage Bay Hatchery through an isolated research program with an annual release of approximately 90,000 smolts at a size of 30 fpp (114 mm fl). The goal of the program is to provide fish to support research programs by the University of Washington and educational activities for undergraduate and graduate students. In addition, the programs offer K-12 outreach opportunities for Puget Sound region schools.

Summary of Program Evaluation and Risk Aversion Measures: Predationand competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures summarized in Table 38.

Operational Commitments:

- WDFW/UW will continue to use gametes from coho salmon adults that voluntarily enter into the Portage Bay (UW) Hatchery holding pond. Coho collection and spawning takes place from late September to December, subsequent to the passage of naturally produced

Chinook salmon through Portage Bay. Therefore, coho salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW/UW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 90,000 zero-aged smolts at a size of 30 fpp (114 mm fl).

- As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

Table 39. Summary of risk aversion measures for the Portage Bay (UW) Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water may be obtained either from either surface water from Portage Bay, well water, or domestic water provided by the City of Seattle.
Intake Screening	4.2	The intake for the Portage Bay water source is believed to meet NOAA fish screening guidelines.
Effluent Discharge	4.2	No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection	7.9	Returning adult coho salmon voluntarily enter the trap off of Portage Bay. Any unmarked Chinook salmon that enter the pond will be returned to Portage Bay.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>Ballard Net Pen Coho Program:</u> Coho salmon are produced from a cooperative program with the Ballard Salmon Club located in Shilshole Bay near Ray's Boathouse. The isolated harvest program releases 30,000 smolts at a size of 17 fpp (137 mm fl). Broodstock collection and initial rearing occurs at the Soos Creek Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: These programs pose minimal risks to listed salmonids because of the release location, the size of the fish at release, and the time of release. Competition or predation impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 39.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of coho for release from a net pen located in Shilshole Bay to a total maximum of 30,000 yearlings at a size of 17 fpp (137mm fl). Fish for the net pens come from the Soos Creek Hatchery.

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation as well as to decrease time spent in the near shore environment and minimize the likelihood for interaction with natural Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns (HSRG recommendation).

Table 40. Summary of risk aversion measures for the Ballard Net Pen Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from Soos Creek and well water is regulated under permits: S1-21122c, S1-22503c and S1-22667a. Water is routed to the creek immediately below the hatchery.
Intake Screening	4.2	Intake screens at the Soos Creek Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Soos Creek Hatchery is regulated through NPDES permit WAG 13-3014.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter a trap in Soos Creek in a time period (October through December) when few Chinook salmon are present. Any unmarked Chinook salmon that enter the trap will be placed upstream.
Disease Transmission	7.9, 10.11	This program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, life-history stage (smolts), and location to minimize competition in fresh- and estuarine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Sockeye Salmon

Cedar River Sockeye Program**:** This integrated harvest program volitionally releases 16 million sockeye fry between January and April at 2,000 fpp. The egg take goal is 18,880,000 with a broodstock collection level of up to 12,000 adults (1:1). The program goal is to increase the number of fry entering Lake Washington and ultimately increase the number of returning adult sockeye.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the species released. Ongoing and proposed riskaversion measures for this program are summarized in Table 40.

Operational Commitments:

- WDFW will continue to use gametes from sockeye salmon adults being trapped on the Cedar River. During collection of sockeye broodstock between September and November there is a potential to take listed Chinook salmon through migrational delay, capture, handling and upstream release. Protocols are in effect to minimize potential impacts to Chinook. The weir will only be operated when sockeye broodstock must be collected; otherwise, the weir is left open to allow passage of Chinook salmon. During the 3-4 days of weir operation per week, operational protocols require checking the trap 2-3 times per day. If Chinook salmon are observed aggregating below the weir, it will be opened to promote upstream passage of returning adults.

- WDFW will limit, as the management intent, annual production of sockeye salmon for on-station volitional release into the Cedar River to a total maximum of 16,000,000 fry.

- WDFW will allow volitional release of sockeye fry between January and April at 2,000 fpp.

- WDFW will, as a management intent, apply an otolith mark to 100% of the sockeye fry volitionally released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns (HSRG recommendation).

Table 41. Summary of risk aversion measures for the Cedar River Sockeye program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water is obtained from four surface springs (S1-27123p) and routed to the Cedar River.
Intake Screening	4.2	No listed species of salmonids are present within the water source.
Effluent Discharge	4.2	No effluents are discharged from this program (incubation only). ?.
Broodstock Collection & Adult Passage	7.9	Broodstock are collected at a temporary weir that is constructed each year at RM 6.4. Protocols are in effect to minimize potential impacts to Chinook. The weir will only be operated when sockeye broodstock must be collected; otherwise, the weir is left open to allow passage of Chinook salmon. During the 3-4 days of weir operation per week, operational protocols require checking the trap 2-3 times per day. If Chinook salmon are observed aggregating below the weir, it will be opened to promote upstream passage of returning adults.
Disease Transmission	7.9, 10.11	This program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history, feeding habits, and behaviorial attributes of sockeye salmon are expected to result in limited competitive and predatory interactions with listed Chinook and summer chum salmon.

Duwamish/Green River

Ecological Context for Hatchery Production

This region includes the Duwamish/Green River and five smaller tributaries entering the Puget Sound independently of the Green River with limited spawning and rearing potential for anadromous salmonids. From the mouth of the river at Elliot Bay to Tukwila, the lower ten miles of this river system is known as the Duwamish River. Above Tukwila is the Green River. This reflects historical drainages patterns that have been modified by development. Prior to 1900, the Lake Washington, Sammamish, and Cedar rivers (via the Black River), Green River, and White River once were tributaries of the Duwamish River. Today, only the Green River maintains this connection. The basin includes 367 identified streams and 643 linear stream miles. The Green River originates in the high Cascades, but in the lower 30 miles where it flows across an open valley, urbanization and industrialization are rapidly replacing open farmland and stands of conifer and deciduous forests.

At least eight stocks of anadromous salmonids of six species occur inthe area. Chinook salmon are listed as threatened under ESA and the status of Green River summer steelhead is depressed. The status of other stocks is healthy or unknown (Table 41). Hatchery programs occur on 5 of these stocks and are primarily focused on providing harvest that cannot be supported by the natural population.

Changes in salmon habitat of the Duwamish/Green rivers severely constrain natural production of salmonids. In the Duwamish River, urbanization and industrial conversion of the land during the growth of Seattle and its suburbs has led to loss of 97% of the historical estuarine mudflats, marshes, and riparian swamps. The river channel was shortened and hardened to allow for navigation. Bottom sediments are polluted from stormwater and wastewater discharges. In the lower Green River, construction of revetments has disconnected side-channel habitat that were once used by salmonids from the river and the river has lost large woody debris and associated pools and riffles. In the middle Green River, construction of the Howard Hanson Dam blocked upstream passage of salmon and reduced recruitment of gravel and large woody debris to the river that is necessary for maintaining salmon spawning and rearing areas. In tributaries, agriculture, residential, and urban development have reduced stream riparian areas, increased impervious surfaces leading to hydrological changes in stream flow, decreased water quality, and led to introductions of potentially harmful non-native species. Above Howard Hanson Dam, periodic inundations from flood-control operations reduce spawning habitat and passage through the reservoir pool can delay juvenile outmigration.

WDFW and the tribes operate two major hatcheries and several rearing ponds and net pens inthis region. WDFW operates Soos Creek Hatchery, a major producer of Chinook and coho salmon eggs and fry for other Puget Sound facilities. Icy Creek Ponds are located on Icy Creek and provide satellite rearing for Soos Creek Hatchery. WDFW also operates the Palmer Rearing Ponds, which are located at RM 56 on the Green River and produce winter and summer steelhead. The Muckleshoot Indian Tribe operates Keta Creek Hatchery and the Crisp Creek Rearing Pond approximately seven miles upstream of Soos Creek Hatchery. Finally the Suquamish and Muckleshoot Indian tribes cooperate on the Elliot Bay net pens in Elliot Bay.

Table 42. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Duwamish/Green River Basin. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Duwamish/Green[6]	Threatened[2]	Integrated harvest
Coho salmon	Green River/Soos Creek	Healthy[3]	Integrated harvest
Chum salmon	Duwamish/Green fall Crisp Creek fall	Unknown[2] Unknown[2]	- Integrated harvest
Steelhead	Green (Duwamish) summer Palmer Pond summer Green (Duwamish) winter Palmer Pond winter	Depressed[3] Hatchery Healthy[3] Hatchery	- Isolated harvest - Isolated harvest
Bull trout/ Dolly Varden[1]	Green (Duwamish)	Unknown[4]	-
Cutthroat trout	Green (Duwamish)	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

Soos Creek Coho Program: Coho salmon are produced at the Soos Creek Hatchery through an integrated harvest program with an annual release of approximately 600,000 smolts at a size of 17 fpp (137 mm fl). An additional 350,000 fry at a size of 600 fpp (42 mm fl) are planted throughout the Green River watershed. Egg take goal is 2,825,000 with a broodstock collection level of up to 2,300 adults (1:1). Eggs and/or fish are also supplied to various tribal, volunteer and educational projects (25,000 to the Seattle Aquarium).

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures summarized in Table 42.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Soos Creek Hatchery for broodstock. Coho collection and spawning takes place from October to late November; Chinook salmon have generally completed spawning by the end of October. Any unmarked Chinook salmon captured in the trap will be placed upstream.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho for release to a total maximum of 600,000 yearlings (17 fpp, 137 mm fl) and 350,000 fed fry at 600 fpp (42 mm fl).

- As a risk aversion measure, the coho salmon will also be released at a time (late April and May), size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho yearling smolts released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns (HSRG recommendation).

- WDFW will apply to the yearling coho a 45k CWT/AD and 45k CWT-only double index coded-wire tag group (DIT) to allow for selective fisheries, the evaluation of fishery contribution, overall survival rates and straying levels to other Puget Sound watersheds.

- WDFW will commit funds for the design of aan adult holding and sortin pond (HSRG recommendation).

Table 43. Summary of risk aversion measures for the Soos Creek Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from Soos Creek and well water is regulated under permits: S1-21122c, S1-22503c and S1-22667a. Water used in the hatchery is routed to Soos Creek immediately below the hatchery.
Intake Screening	4.2	Intake screens at the Soos Creek Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Soos Creek Hatchery is regulated through NPDES permit 13-3014.
Broodstock Collection	7.9	Coho salmon voluntarily enter a trap in Soos Creek in a time period (October through December) when few Chinook salmon are present. Any unmarked Chinook salmon that enter the trap will be placed upstream.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>Keta Creek (Crisp Creek Ponds) Coho Salmon</u>: This coho salmon rearing program is operated by the Muckleshoot Indian Tribe to provide fishing opportunity that is not available from naturally spawning populations. The production objective is to release 400,000-500,000 yearling coho salmon into Elliot Bay. Fingerling coho salmon are transferred from WDFW's Soos Creek Hatchery to Muckleshoot Indian Tribe's Crisp Creek ponds at about 80 fish/pound size in early August each year. Fish are fed artificial feed supplemented by 10-15% natural diet and monitored for fish health but are otherwise left to grow undisturbed until the first week in March, when they are transferred to the Elliot Bay Coho Salmon Net Pens for release (see below). Currently, 50,000 are tagged with coded-wire tags each year.

The effects of this program on Chinook salmon are insignificant, because the program does not involve either brood stock collection (see WDFW Soos Creek Coho Salmon HGMP) or releases into waters where coho salmon can interact with Chinook salmon (see Elliot Bay Coho Salmon Net Pen HGMP for discussion of releases).

<u>Elliot Bay Coho Salmon Net Pens</u>: The purpose of this coho salmon rearing program is to mitigate for treaty fishing opportunity that was lost because of the construction of the Elliot Bay Marina. The program is jointly operated by the Suquamish and Muckleshoot Indian Tribes. Current production objectives are to release 400,000-500,000 yearling coho salmon, although 1,000,000 coho salmon were to be released under the original plan. Fish are transferred from Muckleshoot Indian Tribe's Crisp Creek Ponds in early March into the Elliot Bay Net Pens at approximately 20 fpp (120 mm fl) in size. Coho salmon remain in the net pens until the second week of June when they are released at approximately10 fpp (155 mm fl).

The effects of this program on listed Chinook salmon are unknown. The program does not impact Chinook salmon by brood stock collection because it does not collect its own brood stock (see Soos Creek Coho Salmon HGMP). Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition and predation on non-listed hatchery Chinook salmon could occur in Elliot Bay or other nearshore areas of the Puget Sound after release. Two strategies are intended to minimize, however. Delayed release of coho salmon in mid June may allow Green River Chinook to migrate through the Duwamish waterway and Elliot Bay and quickly disperse before the coho salmon are released. In addition, Chinook salmon are unlikely to remain in the area, because the net pens are positioned at the mouth of the Duwamish River in Elliot Bay, where natural nearshore habitats have been vastly modified or destroyed by commercial development around the Seattle waterfront and may not encourage prolonged residency.

Steelhead

Palmer Ponds Winter Steelhead Program: Winter steelhead are produced at the Palmer Ponds facility through an isolated harvest program with an annual release of approximately 220,000 (150,000 on-station; 35,000 at Soos Creek; 20,000 at Icy Ck: and 15,000 at Flaming Geyser Park Pond) smolts at a size of 5 fpp (208 mm fl). In addition, 100,000 fish are transferred to the Muckleshoot Tribal facility at Keta Creek. The broodstock collection goal is 200 adults (1:1) with a 300,000 egg take goal.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Move the release location for 35,000 yearling winter steelhead smolts to Soos Creek to reduce by 40% the number of river miles that releases from the program may interact with Chinook salmon juveniles; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 43.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Palmer Pond, Keta Creek, and Soos Creek facilities for broodstock. Steelhead collection and spawning takes place from December to late February while listed Chinook are entering and spawning in the river from July through October. Therefore, steelhead broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of steelhead to a total maximum release of 220,000 yearling smolts (150,000 on-station; 35,000 at Soos Creek; 20,000 at Icy Ck. and 15,000 at Flaming Geyser Park Pond) at a size of 5 fpp (208 mm fl). Beginning in May, 2003, 35,000 fish will be released from Soos Creek rather than Palmer Ponds. This results in a more than 40% reduction (22.6 river miles) in the number of river miles in which the winter steelhead releases may interact with Chinook salmon juveniles.

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May 1 and May 15). As a risk aversion measure, the winter steelhead salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead yearlings released to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 44. Summary of risk aversion measures for the Palmer Ponds Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of spring water is regulated under certificate S1-*20296cwris. Rearing. Usage of surface water from Soos Creek and well water is regulated under permits: S1-21122c, S1-22503c and S1-22667a.
Intake Screening	4.2	Incubation and Rearing. No listed salmonids exist in the water source for Palmer Ponds. Rearing. Intake screens at the Soos Creek Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from Palmer Ponds is regulated through NPDES permit 13-3002. Rearing. Effluent from the Soos Creek Hatchery is regulated through NPDES permit WAG 13-3014.
Broodstock Collection	7.9	Winter steelhead voluntarily enter an off-channel trap during a time period (December through mid-February) when Chinook salmon are not likely to be present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Release of 35,000 fish moved to Soos Creek resulting in a 40% reduction in the number of river miles in which the winter steelhead smolt releases may interact with Chinook salmon juveniles. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Palmer Ponds Summer Steelhead Program: Summer steelhead are produced at the Palmer Ponds facility through an isolated harvest program with an annual release of approximately 80,000 yearling smolt (30,000 on-station; 30,000 at Soos Creek and 20,000 at Icy Ck.). Eighty adults (1:1) are needed to attain an egg take goal of ~ 120,000.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Move the release location for 30,000 yearling summer steelhead smolts to Soos Creek to reduce by 40% the number of river miles that releases from the program may interact with Chinook salmon juveniles; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 44.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Palmer Pond and Soos Creek facilities for broodstock. Steelhead collection and spawning takes place between September and November while listed Chinook are entering and spawning in the river from July through October. At the facilities, any unmarked Chinook salmon that may enter the traps will be returned to the Green River or Soos Creek.

- WDFW will limit, as the management intent, limit annual production of steelhead for release to a total maximum of 80,000 yearlings at a size of 5 fpp (206 mm fl). Beginning in May, 2003, 38% of the production (30,000 fish) will be released from Soos Creek rather than Palmer Ponds. This results in a more than 40% reduction (22.6 river miles) in the number of river miles in which the releases may interact with Chinook salmon juveniles.

- WDFW will release summer steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May 1 and May 15). As a risk aversion measure, the summer steelhead will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead yearlings released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 45. Summary of risk aversion measures for the Palmer Ponds Summer Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of spring water is regulated under certificate S1-*20296cwris. Rearing. Usage of surface water from Soos Creek and well water is regulated under permits: S1-21122c, S1-22503c and S1-22667a.
Intake Screening	4.2	Incubation and Rearing. No listed salmonids exist in the water source for Palmer Ponds. Rearing. Intake screens at the Soos Creek Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from Palmer Ponds is regulated through NPDES permit WAG 13-3002. Rearing. Effluent from the Soos Creek Hatchery is regulated through NPDES permit WAG 13-3014.
Broodstock Collection	7.9	Winter steelhead voluntarily enter traps located in Soos Creek or the outfall from Palmer Ponds from September through November. Any unmarked Chinook salmon that enter the traps will be returned to the Green River or Soos Creek.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Release of 30,000 fish moved to Soos Creek resulting in a 40% reduction in the number of river miles in which the summer steelhead smolt releases may interact with Chinook salmon juveniles. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Keta Creek Steelhead: The Muckleshoot Indian Tribe operates this program with the goal of reestablishing steelhead in the Green River above Howard Hanson Dam and supplementing natural production. The production objective is to release 40,000-100,000 steelhead fry annually in the Green River and tributaries. Approximately 20-60 wild steelhead adults are collected by hook and line in the Green River in March, transported to Keta Creek Hatchery, and spawned. Eggs are incubated at Keta Creek Hatchery and hatched fry are transferred to 12 foot fiberglass tanks or concrete raceways for rearing. In August, fry (approximately 150-400 fish/pound in size) are transferred by tank trunks and transported to release locations in the Green River for release.

The effects of this program on Chinook salmon are minimal. Brood stock collection has little negative impact on Chinook salmon because adult Chinook salmon are not in the river at that time. Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Predation on Chinook salmon, which can be a significant impact from yearling steelhead, is greatly reduced by releasing fry, which are too small to prey as effectively. Potential competition between steelhead and Chinook salmon is minimized by distributing the fry in smaller release numbers across different release locations in the watershed.

Chum Salmon

Keta Creek (Crisp Creek) Fall Chum Salmon: The purpose of this program, which is operated by the Muckleshoot Indian Tribe, is to provide harvest on fall chum salmon. The program began in 1975 as a restoration program using fish from Hoodsport Hatchery that had a similar life history to depressed local stocks and then switched to East Kitsap (Grover's Creek) stocks in 1989 and to returns to Keta Creek in 1996. The program has changed to an integrated harvest program as abundance of chum salmon has increased in the Green River. The production objective is to release up to 3,000,000 chum salmon from Keta Creek Hatchery. Approximately 750-2,500 brood fish are collected at the Keta Creek trap in November and December. Fish are spawned andeggs are incubated at Keta Creek Hatchery. Fry are reared in standard raceways saturated with injected oxygen. Fish are released at a size of approximately 150-450 fish/pound in April to May into Crisp Creek.

Independent Bays and Tributaries

This area includes the small independent streams of the East Kitsap Peninsula and islands along Colvos Passage, Sinclair Inlet, Dyes Inlet, Port Orchard, Liberty Bay, Port Madison, which are part of Water Resource Inventory Area (WRIA) 15 and the independent baysof the eastern shore of Puget Sound. On the East Kitsap Peninsula, the division between independent bays and tributaries of the mid-Puget Sound and the south Puget Sound is loosely designated at the Tacoma Narrows. Many of the hatchery programs and fisheries in inlets, bays, and independent streams of the southern Kitsap Peninsula are managed as part of South Sound.

Ecological Context for Hatchery Production

At least six stocks of four species of anadromous salmonids are unique to this area of Puget Sound (Table 45). Self-sustaining, independent Chinook salmon populations do not occur in these systems, although natural production occurs in larger drainages of this area, such as Coulter, Rocky, Minter, Burly, Gorst, Chico, Dogfish, and Burley creeks on the East Kitsap Peninsula. Chinook salmon spawning in these areas are considered part of the complex South Sound fall Chinook stock based on geography (WDF et al., 1993) and genetic influence of Green River hatchery fish. The status of stocks of coho and chum salmon and cutthroat trout is generally healthy or unknown. Hatchery programs occur on 3 of these stocks (Table 45) and are generally focused on providing harvest that cannot be supported by the natural populations.

Changes in salmon habitat resulting from agriculture and development are increasingly constraining natural production of some species of salmonids. The nearshore habitat in this region may be especially important for salmonids from throughout the region. More than twice as many miles of marine and nearshore shorelines exists as available stream miles. Freshwater drainages in this region are small, low elevation, and low gradient, which makes them especially dependent on groundwater and precipitation for flows. With the conversion of forest land to residential and commercial development, less flow is available to sustain salmon rearing during the dry months and the increase in impervious surfaces has increased the frequency and magnitude of peak flows during wet months. This has resulted in increased bank and channel stability, scouring, and loss of salmon habitat. Culverts, screens, and dams block access to spawning areas. The nearshore environment is rapidly changing from residential development. Along the East Kitsap Peninsula, marine nearshore conditions are general better in the north and south than in the central region where development has been greatest. Development has led to extensive shoreline armoring, loss of shoreline riparian shade, and poor water and sediment qualities.

WDFW and tribes have five hatchery facilities in this region. On the eastern shore of Puget Sound, WDFW supports two coperative facilities. The Marine Technology Center in Burien, Washington, is a small hatchery that rears and releases coho salmon for educational programs. The Des Moines coho salmon net pens are located at the Des Moines Marina. On the western shore of Puget Sound along the Kitsap Peninsula, the Suquamish Tribe operates Grovers Creek Hatchery for Chinook salmon, the Agate Pass net pens for coho salmon, and the Cowling Creek Hatchery for chum salmon.

Table 46. Anadromous salmonid species, stocks, stock status, and hatchery strategies of the independent bays and tributaries of the mid-Puget Sound. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Grovers Creekl	NE	Isolated harvest
Coho salmon	East Kitsap Marine Tech/Net Pens	Healthy[3] Hatchery	- Isolated harvest
Chum salmon	Gig Harbor/Ollala Creek fall Dyes Inlet/Liberty Bay fall Sinclair Inlet fall East Kitsap (Cowling Cr.)	Healthy[2] Healthy[2] Healthy[2] Hatchery	- - - Integrated recovery
Steelhead	East Kitsap winter	Unknown[3]	-
Cutthroat trout	Unidentified	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

DesMoines Net Pen Coho Program: Coho salmon are reared from a cooperative program with the Northwest Salmon and Steelhead Club at a net pen located at DesMoines Marina. This isolated harvest program has a total annual release of approximately 30,000 yearling smolts at a size of 17 fpp (137 mm fl). Broodstock collection and initial rearing occurs at the Soos Creek Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: These programs pose minimal risks to listed salmonids because of the release location, the size of the fish at release, and the time of release. Competition or predations impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 46.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of coho for release from a net pen at the Des Moines Marina in central Puget Sound to a total maximum of 30,000 yearlings at a size of 17 fpp (137mm fl). Fish for the net pens come from the Soos Creek Hatchery.

- WDFW will release coho salmon in June to allow Chinook salmon to grow to a size that reduces the potential for predation as well as to decrease time spent in the near shore environment and to minimize the likelihood for interaction with natural Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns (HSRG recommendation).

Table 47. Summary of risk aversion measures for the DesMoines Net Pen Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from Soos Creek and well water is regulated under permits: S1-21122c, S1-22503c and S1-22667a. Water used in the hatchery is routed to Soos Creek immediately below the hatchery.
Intake Screening	4.2	Intake screens at the Soos Creek Hatchery are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent from the Soos Creek Hatchery is regulated through NPDES permit WAG 13-3014.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter a trap in Soos Creek in a time period (October through December) when few Chinook salmon are present. Any unmarked Chinook salmon that enter the trap will be placed upstream.
Disease Transmission	7.9, 10.11	These programs are operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, life-history stage (smolts), and location to minimize competition in fresh and estuarine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>Marine Technology Center Coho Program</u>: This isolated educational program produces 10,000 coho smolts as well as 15,000 fry along a section of Puget Sound shoreline. The release occurs in May at a size of 10-13 fpp (164 – 150 mm fl). The students spawn up to 80 adults (1:1) for egg take purposes. The original broodstock was from the Soos Creek Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: These programs pose minimal risks to listed salmonids because of the release location, the size of the fish at release, and the time of release. Competition or predations impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. The comanagers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts. Ongoing and proposed risk aversion measures for this program are summarized in Table 47.

Operational Commitments:

- WDFW/Marine Tech Center will continue to use gametes from coho salmon adults volunteering into the Marine Tech Center trap located at Seahurst Park (Puget Sound) in Burien, Washington for broodstock. Coho collection and spawning takes place from mid-October to mid-November. No listed Chinook salmon will be affected as they do not occur in the watershed.

- WDFW/Marine Tech Center will limit, as the management intent, annual production of coho for release from the facility to a total maximum of 10,000 yearlings and 15,000 fed fry coho.

- WDFW/Marine Tech Center will release 10,000 yearling coho in May at 10-13 fpp (164-1150 mm fl) and 15,000 fed fry coho at 500 fpp (44 mm fl) in April. Coho are released along a section of shoreline in Puget Sound isolated from any listed populations.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released from the net pen to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 48. Summary of risk aversion measures for the Marine Technology Center Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	No listed salmonids are known to occur in the small stream used as a water source.
Intake Screening	4.2	No listed salmonids are known to occur in the small stream used as a water source.
Effluent Discharge	4.2	No listed salmonids are known to occur in the small stream used as a water source. The hatchery produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects and for the requirement for an NPDES permit.
Broodstock Collection & Adult Passage	7.9	Coho salmon voluntarily enter a pond accessible at high tide from Sehurst Beach. No listed Chinook are know to enter the stream.
Disease Transmission	7.9, 10.11	This program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, life-history stage (smolts), and location to minimize competition in fresh and estuarine waters. Smolts are released in June to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Agate Pass Coho Salmon Net Pens: The purpose of this coho salmon rearing program, which is operated by the Suquamish Tribe, is to provide harvest for Suquamish tribal members, non-Treaty sport fishers and commercial fisheries. The production objective of this program is to release 600,000 yearling coho salmon from the Agate Pass net pens. The program was temporarily reduced in 2003 to 100,000 fish, which were raised at Manchester with the support of the U.S. Navy. All brood stock collection, spawning, incubation, and early rearing is done at WDFW's Minter Creek and Coulter Creek hatcheries. Fingerling coho salmon are transferred from WDFW to net pens at Agate Pass in February or March when fish are physiologically ready to adapt to the salt water. Early transfers in December or January can lead to massive mortalities because of lack of salt water adaptation. Fish are fed daily until they are approximately 10 fish/pound in size. They are released in early June.

The effects of this program on Chinook salmon are most likely minor. Impacts from the program, if they occur, would occur only in the nearshore environment in common with those from many other stocks where potential impacts have been hard to quantify. The program does not impact Chinook salmon by brood stock collection because it does not collect its own brood stock (see WDFW Minter Creek Coho Salmon program for details of brood stock collection). Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Delayed release of coho salmon in June is intended to minimize potential impacts on migrating salmon that may be in the area.

Chum Salmon

Cowling Creek Fall Chum Salmon: The purpose of this program, which is operated by the Suquamish Tribe, is to support tribal treaty fisheries by restoring chum salmon to local East Kitsap Peninsula streams. The production objectives are to release 1,200,000 fed fry into South and North Cowling creeks and 600,000 unfed fry from satellite incubation boxes into independent East Kitsap tributaries of Dogfish, Clear, Barker, and Steele creeks. The program was started in 1977 with brood stock from Hood Canal (Quilcene River). Returning adults were not spawned, however, and subsequent brood fish were collected from Chico Creek, a local stream. Approximately 4,000 brood fish are currently collected annually from adults returning to Cowling Creek. Fish are spawned at the Cowling Creek facility. Eggs for release from satellite incubation boxes in Dogfish, Clear, Barker, and Steele creeks are transferred as water-hardened eggs to the incubation boxes. Most of the eggs are incubated under natural conditions in Netarts rearing troughs in North Cowling Creek. After hatching, fry are allowed to volitionally migrate into circular ponds for initial feeding. Once fry are actively feeding, they are allowed to migrate downstream to an earthen rearing pond on South Cowling Creek where they can grow under natural conditions. Fish are released from Cowling Creek into the estuary on high tides in late April or May.

The effects of this program on Chinook salmon are minimal. Brood stock collection has no negative impact on Chinook salmon. No Chinook salmon occur in Cowling Creek, which is small and has inadequate flows for the species. Self-sustaining populations of Chinook salmon do not occur in this area of the Puget Sound and no adult Chinook salmon have ever been captured at Grovers Creek Hatchery in 26 years. Potential disease effects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Potential competition between chum salmon and Chinook salmon from mid-Puget Sound stocks in the nearshore is minimized by releasing the chum salmon into the estuary where they can disperse quickly over a large area. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare.

South Puget Sound Region

This region consists of three major river basins and many smaller independent streams that flow to the Puget Sound. The large rivers include Puyallup, Nisqually, and Deschutes Rivers. Smaller independent streams and creeks included those that flow into Budd, Eld, Totten, Case, Carr and Hammersley Inlets and directly into the Puget Sound (e.g. Chambers Creek). Chinook salmon historically existed within the Puyallup River, the White River (a major branch of the Puyallup River), and Nisqually River basins. The only indigenous Chinook salmon population remaining in this region is White River spring Chinook salmon. Tumwater Falls, a natural geological barrier in Deschutes River, prevented Chinook salmon from using the Deschutes River. Naturally low stream-flows during the summer months and limited spawning and rearing areas for Chinook salmon probably prevented self-sustaining natural production of Chinook salmon in many smaller independent tributaries.

Puyallup and White Rivers

Ecological Context for Hatchery Production
This region consists of the main stem of the Puyallup River and its tributaries. The basin includes over 728 identified streams and rivers providing 1287 linear miles of drainage. The largest tributaries are the White River and Carbon River. The White River originates from the Emmons Glacier on the northeast face of Mount Rainier and is characterized by frequently shifting braided channels, high turbidity and frigid water temperatures. Prior to 1900, it flowed into the Green River, but because of flood control modifications early in the 20th Century, it currently flows approximately 68 miles from its glacial origin to confluence with the Puyallup River at Sumner.

At least 17 stocks of seven species of anadromous salmonids occur in this region. Status of the stocks is mixed. Chinook, steelhead, and pink salmon are depressed (Table 48). The status of most other stocks is unknown or healthy. Hatchery programs occur on 6 of these stocks and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural population.

Human activities have significantly altered the capacity of the Puyallup and White River watersheds to support natural production. Dredging and filling of the estuary began in the late 1800s. Industrial development of the Port of Tacoma and Commencement Bay destroyed 98% of the historical intertidal and subtital habitat. Much of the remaining estuarine habitat is contaminated by chemicals. Construction of dikes, revetments, and levees in the White and Puyallup Rivers to Commencement Bay constrain the rivers. Altered morphology of the stream and increased gravel removal greatly reduce the effective spawning and rearing habitat. Two hydroelectric dams that were impassable to salmon were constructed early in the 20th Century. In the White River, water withdrawal at RM 24 in Buckley for hydropower generation and a major flood control dam at RM 30 affect the passage and stream flow for fish. Inadequate screens at the hydropower project operated by Puget Power contributed significant losses of juvenile salmon migrating out of the upper White River, until their replacement in1996. In the Puyallup River, the Electron Dam at RM 42 currently blocks 26 miles of anadromous fish habitat, although passage using a fish ladder may soon be possible. Other impassable barriers exist on smaller tributary streams.

Table 49. Anadromous salmonid species, stocks, stock status, andhatchery strategies in the Puyallup and White River basins. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	White River[6] Puyallup[6]	Threatened[2] Threatened[2]	Integrated recovery Integrated harvest
Coho salmon	Puyallup White	Healthy[3] Healthy[3]	Integrated harvest/recovery Integrated harvest
Chum salmon	Puyallup/Carbon fall Fennel Creek fall Hylebos Creek fall Diru Creek late fall	Healthy[3] Healthy[3] Unknown[3] Healthy	- - - Integrated harvest
Pink salmon	Puyallup	Depressed[3]	-
Steelhead	Mainstem Puyallup winter White River winter Carbon River winter Voights creek winter	Depressed[3] Depressed[3] Depressed[3] NE	- - - Isolated harvest
Bull trout/ Dolly Varden[1]	Puyallup White River Carbon River	Unknown[4] Unknown[4] Unknown[4]	- - -
Cutthroat trout	Puyallup	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

WDFW and the tribes operate seven hatchery facilities in the Puyallup River basin. WDFW operates Voights Creek Hatchery and Puyallup Hatchery. Voights' Creek Hatchery is located at on Voights Creek, a tributary to the Carbon River, which flows into the Puyallup at RM 18. It can produce Chinook, coho, pink salmon, and steelhead. The Puyallup Hatchery is located in the town of Puyallup and primarily rears Chambers Creek winter steelhead, Skykomish (Skamania) summer steelhead, kokanee, and trout. The Puyallup Tribe operates Diru Creek Hatchery, which is located on a small tributary of Clarks Creek that flows into the Puyallup River at RM 6, and the Puyallup River Acclimation Ponds. Two ponds are located on the Mowich River, the Mowich River Acclimation Pond (RM 0.2) and the Rushingwater Acclimation Pond on Rushingwater Creek (RM 1). The Cowskull Creek Acclimation Pond is located at RM 45 of the Puyallup River on Cowskull Creek. In the White River, the Muckleshoot Indian Tribe operates the White River Hatchery. It is located at RM 23 near the water diversion dam near Buckley, Washington.

Coho Salmon

Voights Creek Coho Salmon: The goals of this integrated program are to provide adult fish for harvest opportunity and to re-introduce coho above Electron Dam on the upper Puyallup River. A total of 780,000 coho are released annually from Voights Creek in April and May at a size of 17 fpp (137 mm fl). Since 1995, the release has been reduced from 1,180,000 to the present release level. In addition, 200,000 are transferred to the Puyallup Tribe's acclimation sites in the upper Puyallup to re-introduce coho above the Electron Dam. The broodstock collection level is approximately 1,100 adults (1:1) with an egg take goal of 1.4 million.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Reduce program size by 34% from the 1994 through 1999 brood year level of approximately 1,180,000; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 49.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults that voluntarily enter into Voight's Creek Hatchery for broodstock. Coho collection and spawning takes place from October through November. Listed Chinook salmon have the potential of being impacted while collection of coho salmon occurs at the hatchery in October. Disposition of any unmarked Chinook that enter the pond will be consistent with broodstock protocols for the integrated Chinook salmon program conducted at this facility.

- WDFW will review information on the hatchery-natural composition of fish spawning in the river and at the hatchery to determine if modifications in broodstock collection procedures are necessary to achieve the goals for this integrated program (HSRG recommendation).

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 780,000 yearlings at a size of 17 fpp (137 mm fl). The release numbers have been reduced by 34% relative to the 1995 through 1999 brood year levels (reduction from 1,180,000 to the present level of 780,000 yearlings). In addition, 200,000 are transferred to the Puyallup Tribe's acclimation sites in the upper Puyallup to re-introduce coho above the Electron Dam (see Puyallup tribal HGMP).

- WDFW will release 390,000 in April and 390,000 in May to allow Chinook salmon to grow to a size that reduces the potential for predation. As a risk aversion measure, the coho salmon will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will commit funds for the design and construction of an upgraded pollution abatement pond (HSRG recommendation).

Table 50. Summary of risk aversion measures for the Voights Creek Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from Voights Creek is regulated under permits: S2- 4259, S2-19422c and S2-22190c. A gravity water intake is located approximately ½ mile upstream from the hatchery is supplemented with three pumps located at the hatchery. Water used in the hatchery is routed to the river immediately below the hatchery.
Intake Screening	4.2	The gravity intake may not be compliant with NOAA fish screening standards but funding has been provided for a replacement. The pump intakes are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1035.
Broodstock Collection	7.9	Coho salmon voluntarily enter an off-channel pond from October through November. Chinook salmon may be present from July through October. Disposition of any unmarked Chinook that enter the pond will be consistent with the broodstock protocols for the integrated Chinook salmon program conducted at this facility.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Program size reduced by 34% relative to the 1995 through 1999 brood year levels. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

<u>Puyallup Coho Salmon Acclimation Site</u>
The purpose of this coho salmon rearing and acclimation program is to restore coho salmon to the upper Puyallup River. The program began in 1998 and is operated by the Puyallup Tribe. The production objective is to release 200,000 coho salmon from three acclimation ponds on the Mowich and upper Puyallup rivers. Brood fish for this program are collected by WDFW at Voights Creek Hatchery, where the fish are spawned, the eggs are incubated, and hatched fish are reared to the yearling stage. Fish are transported to the acclimation ponds in late January. Yearling coho salmon are released when they show signs of smoltification or migratory behavior in later April to mid May.

The effects of this program are most likely minimal. Brood stock collection has little negative impact on Chinook salmon because it is not part of this program (see Voights Creek coho salmon program for details). Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Potential competition and predation could occur between coho salmon and Chinook salmon during juvenile outmigration because of the overlap outmigration timing. Current strategy to reduce these interactions is to 1) hold the fish until they are showing visual signs of smoltification, when physiological changes are most likely to promote rapid outmigration and reduce the time the coho salmon encounter Chinook salmon, 2) release the fish at relatively smaller sizes (18-28 fish/pound), which reduces the likelihood of predation, and 3) release acclimated fish high in the watershed, which allows them time and space to disperse.

Steelhead

Voights Creek Winter Steelhead Program: Winter steelhead are produced at the Voights Creek Hatchery through an isolated harvest program with an annual release of approximately 200,000 smolts at a size of 9 fpp (170 mm fl). Broodstock collection is at a level of ~ 250 adults (1:1) with adults collected at two facilities: Voights Creek Hatchery and Puyallup Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Delay the release of steelhead smolts from April to between May1 and May 15 (HSRG recommendation); and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 50.

Operational Commitments:

- WDFW will continue to use gametes from steelhead adults volunteering into the Voight's Creek facility as well as at Diru Creek and Puyallup hatcheries for broodstock. Winter steelhead collection and spawning takes place from late November to late February while listed Chinook are entering and spawning in the river July through October. Therefore, steelhead broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of steelhead for on-station release to a total maximum of 200,000 yearlings at a size of 9 fpp (170 mm fl).

- WDFW will release winter steelhead in May to allow Chinook salmon to grow to a size that reduces the potential for predation (HSRG recommended release between May and May 15). As a risk aversion measure, the winter steelhead yearling smolts will also be released at a time, size, and life history stage (smolted) that fosters rapid migration to salt water. This helps minimize possible interactions with listed Chinook salmon juveniles.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead yearlings released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 51. Summary of risk aversion measures for the Voights Creek Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water from Voights Creek is regulated under permits: S2- 4259, S2-19422c and S2-22190c. A gravity water intake is located approximately ½ mile upstream from the hatchery is supplemented with three pumps located at the hatchery. Water used in the hatchery is routed to the river immediately below the hatchery.
Intake Screening	4.2	The gravity intake may not be compliant with NOAA fish screening standards but funding has been provided for a replacement. The pump intakes are believed to be compliant with NOAA fish screening standards.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1035.
Broodstock Collection	7.9	Winter steelhead voluntarily enter an off-channel trap from late November to late February while listed Chinook salmon may be present from July through October.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Smolts are released in May to allow Chinook salmon to grow to a size that reduces the potential for predation. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Chum Salmon

Diru Creek Late Fall Chum Salmon: The purpose of this program is to mitigate for lost fish opportunity and provide for tribal treaty harvest of chum salmon. It is operated by the Puyallup Tribe. The production objective of the program is to release 2,000,000 late-run fall chum salmon from Diru Creek Hatchery. The program began 1979 with broodstock from Chambers Creek, an independent tributary entering the Puget Sound south of the Puyallup River. Approximately 2,275 brood fish are collected and spawned at Diru Creek Hatchery in December and January. Eggs are incubated at the hatchery and hatched fry are initially reared in 16 shallow troughs and moved to raceways or ponds for final rearing. Fry are released at 300-1000 fish/pound in late April and early May from Diru Creek Hatchery.

The effects of this program on listed populations of Chinook salmon or bull trout are minimal. Brood stock collection has little impact on Chinook salmon. Brood stock collection occurs after Chinook salmon have completed spawning. Most natural spawning of Puyallup River fall Chinook is completed by early November. White River spring Chinook do not spawn in this area and they have completed spawning by late September or early October. Potential disease affects of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Potential competition is reduced by releasing the fish in late April and early May. Because of life history and developmental differences, such as the small size of chum salmon (300-1000 fish/pound), predation by juvenile chum on Chinook salmon would be extremely rare.

Nisqually River

Ecological Context for Hatchery Production
This basin includes the Nisqually River drainage and McAllister Creek, a short stream that flows independently into the Puget Sound. The basin has approximately 715 linear miles of river and tributary streams. The Nisqually River flows from the Nisqually Glacier on Mount Rainier 72 miles to the Puget Sound. Compared to other Puget Sound rivers, the Nisqually River is predominantly a main stem river without extensive tributaries. The upper 30 miles of main stem habitat and 300 miles of tributary habitat have numerous cascades and rapids with pool and riffle sections characteristic of Cascade salmon streams. This area is now inaccessible to anadromous salmon because of the construction of the Alder and LaGrande dams built for hydroelectric power generation by the City of Tacoma. Below the Alder-LaGrande Dam complex the river gradient lessens and salmon habitat consists of extensive deep riffles, glides, and pools. At RM 25, a fish ladder provides passage over a dam that diverts water through the Yelm Power Canal, which empties back into the river near RM 11. Below the Alder-LaGrande Dam complex, the Mashel River, which is 20 miles long and has an additional 67 linear miles of tributary streams, provides the largest amount of tributary salmon habitat. Numerous small, low gradient spring-fed tributaries also enter the Nisqually River below the LaGrande Dam. McAllister Creek is an independent low gradient, spring-fed stream that flows 6 miles to the Nisqually River delta.

At least seven stock and species of anadromous salmonids occur in the Nisqually River watershed (Table 51). Chinook salmon and steelhead stocks are the most vulnerable to extinction. Coho and chum salmon stocks, in contrast, are healthy. The status of other stocks is unknown. Hatchery programs occur on two of these species and are focused on providing harvest that cannot be supported by the natural population.

Salmon production in the Nisqually River is limited by loss of estuarine function, altered hydrological regimes, and conversion of valley bottom lands and wetlands to agriculture and residential developments. Diking of the estuary, which began in 1904, eventually led to 30% loss of historical intertidal and subtidal habitat. In the main stem of the river, channel containment structures have eliminated much of the spawning and off-channel rearing habitats. Like many Puget Sound rivers, the commercial timber activities have reduced inputs of large woody debris in the river. For much of its history, the water diversion dam for the Yelm Power Canal impeded upstream and downstream passage of fish, but this has since been corrected. Although Alder Dam blocks upstream migration of fish, this may not eliminate much historical spawning habitat because a natural barrier to migration existed in LaGrande Canyon near the dam location.

The Nisqually Indian Tribe operates two hatchery facilities on the Nisqually River. Clear Creek Hatchery and Kalama Creek Hatchery are located at river mile 6 and 9, respectively, and produce Chinook and coho salmon.

Table 52. Anadromous salmonid species, stocks, stock status, and hatchery strategies in the Nisqually River Basin. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Nisqually[6]	Threatened[2]	Integrated harvest
Coho salmon	Nisqually	Healthy[3]	Isolated harvest
Chum salmon	Nisqually winter	Healthy[2]	-
Pink salmon	Nisqually	Unknown[3]	-
Steelhead	Nisqually winter	Depressed[3]	-
Bull trout/ Dolly Varden[1]	Nisqually	Unknown[4]	-
Cutthroat trout	Nisqually	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Puget Sound Technical Recovery Team

Coho Salmon

Kalama Creek and Clear Creek Coho Salmon
The purpose of these programs, which are operated by the Nisqually Indian Tribe, is to provide treaty-reserved fish opportunity for the Nisqually Tribe and other treaty and non-treaty fisheries. Production objectives are to release 350,000 yearling coho salmon from Kalama Creek and 630,000 from Clear Creek annually. The Kalama Creek program began in 1980 and the Clear Creek program began in 1991 with fish from several different Hood Canal and Puget Sound stocks. Brood fish for each program are collected from adult coho salmon returning to the different hatchery adult holding ponds between September and December. In some years, eggs from returning broodstock have been supplemented by eggs from Minter Creek or Soos Creek hatcheries. Approximately 500 and 1,000 brood fish are collected at Kalama Creek and Clear Creek hatcheries, respectively. Fish are spawned and eggs are incubated at the individual hatcheries. Ponding begins in January (Kalama Creek) and February (Clear Creek) and continues as eggs reach the appropriate developmental stage. Raceways are used for initial rearing and then fish are transferred to large rearing ponds. Yearling coho salmon are allowed to migrate volitionally from the ponds throughout April.

The impacts of this program on listed Chinook salmon are unknown but are likely not very great. Impacts during brood stock collection are most likely minimal. Because adult Nisqually River Chinook salmon and Nisqually River coho salmon may be in the river at the same time, some listed, natural origin Chinook salmon may voluntarily enter hatchery holding ponds and be handled during the capture of coho salmon brood stock. Because hatchery managers lacked the means to distinguish hatchery from wild Chinook salmon until recently, quantitative estimates were not possible. The numbers were most likely very small, however, because 1) only a few Chinook salmon usually enter the brood stock capture facilities and the proportion of listed, natural origin spawners is a small proportion of the total returns to the river, 2) the locations of the hatcheries are 6-9 miles below the natural spawning reaches in the Nisqually River, and 3) the low flows and different water chemistry of the hatchery creeks compared to the main stem may be less likely to attract natural origin Chinook salmon. Coho salmon from these programs could potentially compete or prey on listed Chinook salmon in freshwater or the nearshore. The impacts are reduced in a variety of ways. Total annual releases have been reduced by nearly 50% from an average of 1.9 million to 980,000. Fry and fingerling releases have been discontinued to reduce potential competition of the different species of the same size. Migratory, yearling coho salmon are released low down in the rivers to reduce the time and space they share with Chinook salmon. To address the unknown impacts in the nearshore and estuary, the Nisqually Indian Tribe has begun a study of fish distribution and diets in the Nisqually River estuary.

Independent Bays and Tributaries

Ecological Context for Hatchery Production
The Deschutes Rivers and smaller independent streams and creeks that flow into Budd, Eld, Totten, Case, Carr and Hammersley Inlets and directly into the Puget Sound (e.g. Chambers Creek) make up much of the salmon habitat in southern Puget Sound. The Deschutes River is the only large river in this area, but prior to 1954, a series of natural waterfalls (Tumwater Falls), located near the mouth of the Deschutes River between R.M. 1.0 and 1.25 (80 foot gradient) prevented access of Chinook salmon and other anadromous fishes to upstream areas. In 1954, the Washington Department of Fisheries (WDF) completed three fish ladders, circumventing the falls. The majority of tributaries in south Puget Sound are smaller independent systems. At least 28 of these are used by one or more species of salmon. Most of these are short, low or moderate gradient streams originating from natural springs, ground water runoff, swampy beaver ponds or lakes that drain into small estuarine inlets and bays, creating rich production areas for the invertebrates and fish on which salmon prey.

At least 23 stocks of five species of anadromous salmonids occur in this region. No self sustaining populations of Chinook salmon were historically present here, although Chinook salmon that most likely originate from hatcheries in the region may spawn in the larger creeks. any of these small, lowland streams do produce diverse, healthy stocks of chum salmon, steelhead, and cutthroat trout (Table 52). Because of the absence of large, salmon producing rivers, this area has historically had extensive hatchery programs for Chinook and coho salmon. Hatchery programs occur on four of these stocks and focus on providing harvest that cannot be supported by the natural population.

The capacity of local streams for natural production has been reduced by changes in the natural hydrology. Stream flows in this region are influenced by rainfall because they do not drain higher elevation snow pack areas and are consequently subject to low summer flows. Historically, groundwater, wetlands, and beaver ponds helped maintain summer flows for fish. Since the 1850s, however, logging, agriculture, and development have removed riparian cover, filled wetlands, de-stabilized banks and increased erosion and sediments in streams, and decreased water quality. Stream temperatures and dissolved oxygen levels in summer months may exceed levels appropriate for salmonids. In addition, non-native warm-water fishes have been introduced into many streams where they may prey on or compete with salmonids.

Two large hatchery complexes operated by WDFW support most of the hatchery production in this region. The Minter Creek Hatchery Complex is spread through the southern inlets of East Kitsap Peninsula and provides fish for both the mid-Puget Sound and south Puget Sound regions. The South Puget Sound Hatchery Complex is based in the southern most inlets and streams of south Puget Sound. The Minter Creek Hatchery Complex consists of Minter Creek Hatchery, which is located on Minter Creek near the head of Carr Inlet, the Hupps Springs Hatchery, and Coulter Creek Hatchery. Hupps Springs Hatchery is located upstream of Minter Creek Hatchery and supports rearing of White River Chinook salmon. Coulter Creek Hatchery, which is located

Table 53. Anadromous salmonid species, stocks, stock status, and hatchery strategies of the independent bays and tributaries of the south Puget Sound. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Tumwater Falls (Deschutes R.)	NE	Isolated harvest
Coho salmon	Chamber Creeks	Depressed[3]	-
	Deep South South tributaries	Healthy[3]	-
	Minter Creek	NE	Isolated harvest
	Deschutes River	Critical[3]	-
	South Sound Net Pen	NE	Isolated harvest
Chum salmon	Hammersly Inlet summer	Critical[3]	-
	Case Inlet summer	Healthy[3]	-
	Blackjack Creek summer	Healthy[3]	-
	Henderson Inlet fall	Unknown[3]	-
	Eld Inlet fall	Healthy[3]	-
	Totten Inlet fall	Healthy[3]	-
	Skookum Inlet fall	Healthy[3]	-
	Upper Skookum Creek fall	Healthy[3]	-
	Johns/Mill creeks fall	Healthy[3]	-
	Goldsborough/Shelton creeks fall	Depressed[3]	-
	Case Inlet fall	Healthy[3]	-
	Carr Inlet fall	Healthy[3]	-
	Chambers Creek winter	Healthy[3]	-
Steelhead	Deschutes River winter	Not rated[3]	-
	Tumwater Falls	NE	Isolated harvest/research
	Eld Inlet winter	Unknown[3]	-
	Totten Inlet winter	Unknown[3]	-
	Hammersly Inlet winter	Unknown[3]	-
	Case/Carr Inlets winter	Unknown[3]	-
Cutthroat trout	Western South Sound	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)

at the head of Case Inlet, is a rearing facility for eggs taken at the Minter Creek Hatchery. The South Puget Sound Hatchery Complex consists of the Tumwater Fall Rearing Complex and the Skookumchuck Rearing Ponds. Tumwater Falls Rearing Complex includes the holding ponds and trap at Tumwater Falls on the Deschutes River, Percival Cove net pens, Capital Lake net pens, and the South Sound Net Pens, which are jointly operated with the Squaxin Island Tribe in Peale Passage.

Coho Salmon

Minter Creek/Coulter Creek Coho Program: The Puget Sound Technical Recovery Team has not identified Minter Creek or Coulter Creek as a Chinook salmon population. Coho salmon are produced at the Minter Creek Hatchery through an isolated harvest program with an annual release of approximately 1,044,000 yearling smolts. The broodstock requirement is 4,500 adults (1:1), which are used for this program as well as for the South Sound net pens, co-ops (volunteers), educational projects and a Nisqually Tribal program. Smolts are released in May and June at a size of 17 fpp (137mm fl). The size of this program has been reduced by 30% from the 1994 through 1998 brood year level of approximately 1,500,000 smolts.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Reduce program size by 30% from the 1994 through 1998 brood year level of approximately 1,500,000; and
2) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 53.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the Minter Creek Hatchery for broodstock. Coho collection and spawning takes place from October through December while listed spring Chinook from the White River integrated recovery program are collected and spawned from early May through September. . Therefore, coho salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon.

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 1,044,000 yearling smolts at a size of 17 fpp (137 mm fl). The program has been reduced by 30% from the 1998 brood level of 1,500,000 smolts.

- WDFW will release coho salmon in May and June to allow Chinook salmon to grow to a size that reduces the potential for predation. On station plants of spring Chinook salmon from the White River integrated recovery program are released at a size of 50 fpp (96mm fl) in May and 8 fpp(approximately 176mm fl) in April from Hupp Springs.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 54. Summary of risk aversion measures for the Minter Creek/Coulter Creek Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of surface water and well water is regulated under permits S2-04731, S2-07907, S2-21357. Water used in the hatchery is routed to Minter Creek immediately below the hatchery.
Intake Screening	4.2	There are no listed salmonids in Minter Creek above either the gravity or pump intake.
Effluent Discharge	4.2	Effluent from the Minter Creek Hatchery is regulated through NPDES permit WAG 13-1024.
Broodstock Collection	7.9	The PSTRT has not identified Minter Creek as a Chinook salmon population. A barrier dam and trap exist at RM 0.5. Broodstock collection for the White River spring Chinook integrated recovery program occurs at this location from early-May through September. Coho broodstock collection occurs from October through December.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released near the mouth of Minter Creek. The PSTRT has not identified Minter Creek as a Chinook salmon population. Program size reduced by 30% from the 1994 through 1998 brood year level. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Squaxin Island South Sound Net Pens: The purpose of this fish rearing program is to produce fish for harvest opportunities for the Squaxin Island Tribe, non-tribal sport fishers, and commercial fisheries that would not otherwise be available because of limited natural production. The Squaxin Island Tribe began the program in 1972 and it is currently operated cooperatively between the Squaxin Island Tribe and WDFW. The production objective for this program is to release 1,800,000-2,600,000 coho salmon from net pens in Peale Passage. No broodfish are collected as part of this program. Brood stock collection, spawning, incubation, and rearing occur as part of WDFW's Wallace River and Minter Creek programs. Fingerling coho salmon are transferred from WDFW programs to the salt water net pens in late January. They are raised in the net pens until the first two weeks in June when they are released at approximately 11-12 fpp (159mm – 154mm fl) in size directly from the net pens. Releases are staggered over the two week period to allow the fish to disperse.

The effects of this program on listed Chinook salmon and bull trout are minimal. Impacts from the program, if they occur, would occur only in the nearshore environment in common with those from many other stocks where potential impacts have been hard to quantify. Unlike other nearshore areas of the Puget Sound, listed, natural-origin Chinook salmon in this region are rare. The only listed, natural-origin population close to this area is in the Nisqually River, where natural origin recruits make up a small fraction of the production from the river. This fraction becomes even lower in the estuary as the listed fish mix with the large numbers of hatchery produced fish.

The program does not impact Chinook salmon or bull trout by brood stock collection because it does not collect its own brood stock (see WDFW Wallace River and Minter Creek Coho Salmon programs for details of brood stock collection). Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition and predation of coho salmon from South Sound hatchery programs may impact productivity of natural-origin recruits after they enter salt water. Releases from the South Sound net pens try to reduce these impacts in two ways. The net pens are located in a central marine area away from the shallower freshwater estuary areas where natural origin Chinook salmon and other species first enter the Puget Sound. Delayed release of coho salmon in June is intended promote rapid out-migration and use of deeper water habitats that would also potentially reduce competition and predation on Chinook salmon and other species in shallower estuary areas. To understand better whether these strategies are working, the Squaxin Island Tribe has completed a successful pilot study using coho salmon from the net pens implanted with acoustic radio tags that allow biologists to study the migration patterns of the fish after release. The Tribe is requesting addition funds to begin a more comprehensive study that will be able to compare different release strategies.

Steelhead

<u>Tumwater Falls Winter Steelhead Program</u>: Winter steelhead are reared at the Puyallup Hatchery (Clark Creek) and released into the Deschutes River. The PSTRT has not identified the Chinook salmon in the Deschutes River as a population integral to Puget Sound ESU recovery. .

Winter steelhead are produced through an isolated harvest and research program with an annual release of approximately 24,500 yearling smolts from April through June. The intent of the research is to 1) assess the rate of consumption of wild Chinook salmon by hatchery steelhead and 2) evaluate techniques for assessing these impacts so they may be applied to other river systems and hatchery programs.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the release location. Competition or predations impacts from this program, if they occur, would occur in the nearshore environment in common with those releases from a large array of programs. WDFW is conducting an intensive study of predation by winter steelhead smolts on juvenile Chinook salmon in the Deschutes River. The Chinook salmon that spawn naturally are of hatchery origin and were introduced primarily research purposes.

Ongoing and proposed risk aversion measures for this program are summarized in Table 54.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 24,500 yearling smolts at a size of 5 fpp (206 mm fl).

- WDFW will transport (from the Puyallup Hatchery) and release into the Deschutes River in a period from April though June.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead yearlings released from the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 55. Summary of risk aversion measures for the Tumwater Falls Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of springs and surface water from Clark Creek are regulated under permits S2-02586c, S2-19422c, and S2-22190c.
Intake Screening	4.2	No listed salmonids are exist within the water source for this facility..
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1016.
Broodstock Collection	7.9	Winter steelhead voluntarily enter an off-channel pond in a time period (November through January) when Chinook salmon are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	The PSTRT has not identified Dechutes River as a Chinook salmon population. This is the location of an intensive study by WDFW of predation by winter steelhead smolts on juvenile Chinook salmon.

Hood Canal Region

The enclosed waters of Hood Canal form a natural geographic unit. On the eastern side of Hood Canal, lowland streams with moderate gradients flow into Hood Canal from natural springs, ground water runoff, swampy beaver ponds or lakes. The Union, Dewatto, and Tahuya Rivers are the largest of these. On the western side of Hood Canal, major watersheds include the Skokomish, Hamma Hamma, Duckabush, Dosewallips, and Quilcene Rivers. These rivers drain the slopes of the Olympic Mountains and are steep with cascades or waterfalls that limit access of anadromous fish.

Skokomish River and Mid-Hood Canal

Ecological Context for Hatchery Production
The Skokomish River, the largest of the rivers in this region, provides 340 miles of stream drainage. Its two large branches, the North Fork and South Fork, flow for 33 and 28 miles, respectively, from the southern Olympic Mountains where they converge to form nine miles of main stem river before entering the Hood Canal through a large delta. The upper sections of the two branches drop steeply before they lessen to more moderate gradients and finally spill through deep canyons to the valley floor. The South Fork has waterfalls that are impassable to fish at RM 21. The North Fork is inaccessible above lower Cushman Dam. The North Fork also had a natural lake (Lake Cushman), which expanded when the North Fork was dammed for hydroelectric power generation. Currently most of the flow of the North Fork is diverted through a tunnel at Lower Cushman Dam and discharged directly into Hood Canal.

The mid-Canal region (Hamma Hamma, Duckabush, Dosewallips rivers) was most likely a source of historical Chinook populations in Hood Canal, although the interdependence of production from the different rivers is unknown (Puget Sound TRT 2003). The Hamma Hamma River has 18 miles of mainstem and 93 total miles of stream drainage. Most of the river is steep and cascades and a large waterfall between RMs 2-3 prevent migration of salmon farther upstream. To the north, the Duckabush River drops through mountainous, undeveloped terrain of the Olympic National Park for 24 miles. Like the Hamma Hamma River, most of the river is steep. Waterfalls block upstream migration of anadromous fish at RM 7, although cascades 2-3 miles lower down may prevent migration of some species and partially restrict others. The Dosewallips River is narrow and steep as it falls 28 miles from its origins in Olympic National Park. Anadromous fish can move through 22 miles of the mainstem, but canyon walls and waterfalls block access to most tributaries.

At least 33 stocks of seven species of anadromous salmonids occur in the Skokomish River and mid-Hood Canal region. The most vulnerable stocks are Chinook salmon, summer chum salmon, and winter steelhead (Table 55). The status of most other stocks in this region is unknown or healthy. Hatchery programs occur on twelve of these stocks (Table 55) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural populations.

Changes in salmon habitat of the Skokomish River and mid-Hood Canal severely constrain natural production of salmonids. In the Skokomish River, Cushman Dam limits anadromous fish use of the North Fork. Logging and associated road building in upper watersheds has led to loss of riparian buffers, loss of large woody debris recruitment, and increased mass wasting in Skokomish and Dosewallips rivers. In lower parts of the watersheds, agricultural activities and residential development have channelized the main stem of rivers, drained beaver ponds, and decreased channel complexity and stream bank stability. Construction of State Road 101 along the edge of Hood Canal effectively diked large estuaries, disrupting natural sediment transport processes and fragmenting valuable salt marshes and lagoons used by salmonids. Associated residential and commercial development along the highway led to armoring the shoreline and loss of nearshore riparian habitat.

WDFW, the Skokomish Tribe, the Hood Canal Salmon Enhancement Group (HCSEG), and a private aquaculture group, Long Live The Kings (LLTK), operate hatchery facilities in this part of Hood Canal. WDFW operates a well-developed hatchery complex consisting of the George Adams Hatchery, Mckernan Hatchery, Hoodsport Hatchery, and Eells Spring Hatchery. The George Adams Hatchery, which is capable of incubating 90 million eggs and raising 14 million juveniles, is located one mile up Purdy Creek, a tributary of the lower Skokomish River and isa major producer of different species of salmon in the Puget Sound. George Adams Hatchery supports McKernan Hatchery and Hoodsport Hatchery. McKernan Hatchery, which is located on Weaver Creek, a tributary of the lower Skokomish River, primarily raises chum salmon. Hoodsport Hatchery, which is located approximately seven miles north of the Skokomish River on the independent tributary of Finch Creek, can rear a variety of species in fresh, brackish, or saltwater. Eells Spring Hatchery is located upstream of George Adams Hatchery on Hunter Creek, a tributary of the Skokomish River, and raises winter steelhead and trout. The Skokomish Tribe operates the Skokomish Tribal Hatchery at the mouth of Enetai Creek just north of the Skokomish River. The HCSEG operates summer chum, Chinook, and steelhead programs on the Hamma Hamma River. Approximately 10 miles north of the Skokomish River, LLTK operates the Lilliwaup Hatchery, where it raises fall Chinook, summer chum salmon, and steelhead.

Coho Salmon

<u>George Adams Coho Program</u>: Coho salmon are produced at the George Adams Hatchery through an isolated harvest program with an annual release of approximately 500,000 smolts at a size of 17 fpp (137 mm fl). The egg take goal of 590,000 requires about 1,058 adults(1:1 spawning).

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. These potential hazards are addressed through the on-going risk aversion measures summarized in Table 56.

Operational Commitments:

- WDFW will continue to use gametes from coho salmon adults volunteering into the George Adams Hatchery for broodstock. Coho collection and spawning takes place from early October to early December while Chinook salmon are entering George Adams Hatchery from early August through mid-September. Therefore, coho salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon. No summer chum adults are known to return to the Skokomish River.

- WDFW will limit, as the management intent, annual production of coho for on-station release to a total maximum of 500,000 yearlings at a size of 17 fpp (137 mm fl).

Table 56. Anadromous salmonid species, stocks, stock status, and hatchery strategies of the Skokomish River Basin and nearby bays and watersheds. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Skokomish[6]	Threatened[2]	-
	Purdy Creek (George Adams)	NE	Integrated harvest
	Mid-Hood Canal[6]	Threatened[2]	Integrated recovery
	Finch Creek (Hoodsport)	NE	Isolated harvest
Coho salmon	Skokomish	Healthy[3]	-
	Purdy Creek (George Adams)	NE	Isolated harvest
	Southwest Hood Canal	Healthy[3]	-
	Hamma Hamma	Unknown[3]	-
	Duckabush	Healthy[3]	-
	Dosewallips	Unknown[3]	-
Chum salmon	Lilliwaup summer	Threatened[2]	Integrated recovery
	Southeast Hood Canal fall	Healthy[3]	-
	Lower Skokomish fall	Unknown[3]	-
	Purdy Creek (George Adams)	NE	Isolated harvest
	Upper Skokomish fall	Healthy[3]	-
	Weaver Creek (McKernan)	NE	Isolated harvest
	West Hood Canal fall	Healthy[3]	-
	Finch Creek (Hoodsport)	NE	Isolated harvest
	Hamma Hamma summer	Threatened[2]	Integrated recovery
	Duckabush summer	Threatened[2]	-
	Dosewallips summer	Threatened[2]	-
	Hamma Hamma late fall	Healthy[3]	-
	Duckabush late fall	Healthy[3]	-
	Dosewallips late fall	Healthy[3]	-
Pink salmon	Hamma Hamma	Healthy[3]	-
	Duckabush	Depressed[3]	-
	Dosewallips	Depressed[3]	-
	Finch Creek (Hoodsport)	NE	Isolated harvest
Steelhead	Skokomish summer	Unknown[3]	-
	Skokomish winter	Depressed[3]	-
	Duckabush summer	Unknown[3]	-
	Dosewallips summer	Unknown[3]	-
	Hamma Hamma winter	Depressed[3]	Integrated recovery
	Duckabush winter	Depressed[3]	-
	Dosewallips winter	Depressed[3]	-
	Hunter Creek (Eells Springs)	NE	Isolated harvest
Bull trout/ Dolly Varden[1]	South Fork Skokomish	Unknown[4]	-
	Lake Cushman	Healthy[4]	-
	Upper North Fork Skokomish	Unknown[4]	-
Cutthroat trout	West Hood Canal	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SASSI 1992 (WDFW et al. 1993)
[4] 1998 SaSI status (WDFW 1998)
[5] 2000 SaSI status (WDFW 2000)
[6] Puget Sound Technical Recovery Team

- WDFW will release coho yearling smolts from mid- to late-April when they are heavily smolted to encourage quick migration to salt water and minimize the likelihood for interaction with listed Chinook salmon juveniles. The Summer Chum Conservation Initiative requires that no hatchery releases in Hood Canal occur prior to April 1 as a protection measure during out-migration (February-March) of listed Hood Canal summer chum.

- WDFW will, as a management intent, apply an identifiable mark to 100% of the coho smolts released through the hatchery to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will apply a 45KCWT/AD and 45CWT –only double index coded-wire tag group (DIT) to allow for selective fisheries, the evaluation of fishery contribution, overall survival rates and straying levels to other Puget Sound watersheds.

Table 57. Summary of risk aversion measures for the George Adams Coho program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring, well and surface water from Purdy Creek is regulated under permits S2-25769a, G2-24645c, S2-05575c, S2-20811c, and S2-23232c. Water used in the hatchery is routed to Purdy Creek immediately below the hatchery.
Intake Screening	4.2	No listed salmonids exist in the water source for this facility.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1019.
Broodstock Collection	7.9	Coho salmon voluntarily enter a trap on Purdy Creek in a time period (early October through early December) when Chinook salmon are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Fish are released at a time, size, life-history stage (smolts), and location to foster rapid migration to marine waters. Consistent with the SCCI, fry are released after April 1 and yearlings are released after April 15 to limit interactions with listed summer chum. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Steelhead

Eells Springs Winter Steelhead Program: Winter steelhead are reared at the Eells Springs Hatchery through an isolated harvest program with an annual release of approximately 50,000 yearling smolts into the Skokomish River. Incubation and rearing to 100 fpp occurs at the Puyallup Hatchery.

Summary of Program Evaluation and Risk Aversion Measures: Predation and competition are the primary hazards that this program might pose to listed Chinook and summer chum salmon populations. A review of the program suggested the following program modifications as risk aversion measures to address these potential hazards:

1) Eliminate the release of 10,000 yearling smolts in the Duckabush River and 12,500 yearling smolts in the Dosewallips River (HSRG recommendation);
2) Delay the release of winter smolts in the Skokomish River from mid-late April to May 1 to May 15; and
3) Conduct studies in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of coho salmon smolts.

Ongoing and proposed risk aversion measures for this program are summarized in Table 57.

Operational Commitments:

- WDFW will limit, as the management intent, annual production of steelhead for release to a total maximum of 50,000 yearling smolts at a size of 5 fpp (206 mm fl). The facility trucks and plants 50,000 steelhead smolts into the Skokomish River.

- WDFW will release steelhead yearling smolts from May 1 to May 15 (HSRG recommendation) when they are heavily smolted to encourage quick migration to salt water and minimize the likelihood for interaction with listed Chinook salmon juveniles. The Summer Chum Conservation Initiative requires that fry are released after April 1 and yearlings are released after April 15 to limit interactions with listed summer chum salmon during their out-migration (February-March).

- WDFW will, as a management intent, apply an identifiable mark to 100% of the steelhead smolts trucked and planted to allow for monitoring and evaluation of the hatchery program fish releases and adult returns.

Table 58. Summary of risk aversion measures for the Eells Springs Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Incubation and Rearing. Usage of spring water at Eells Springs Hatchery is regulated under certificate S2-05446cwris. Water used in the hatchery is routed to the river immediately below the hatchery.
Intake Screening	4.2	No listed salmonids exist within the water sources for these facilities.
Effluent Discharge	4.2	Incubation and Rearing. Effluent from Puyallup Hatchery is regulated through NPDES permit WAG 13-1016. Rearing. Effluent from Eells Springs Hatchery is regulated through NPDES permit WAG 13-1047.
Broodstock Collection	7.9	Winter steelhead are collected at Clear Creek, Voights Creek and Diru Creek (Puyallup Tribe) facilities on the Puyallup system in a time period (November through January) when Chinook salmon are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Eliminate the release of 10,000 yearling smolts in the Duckabush River and 12,500 yearling smolts in the Dosewallips River. Fish are released in the Skokomish River at a time, size, and life-history stage (smolts) to foster rapid migration to marine waters. Consistent with the SCCI, fry are released after April 1 and yearlings are released after April 15 to limit interactions with listed summer chum. Studies will be conducted in riverine, estuarine, and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Hamma Hamma Steelhead: Steelhead are produced through an integrated recovery/research program involving taking eggs from redds found in the Hamma Hamma River followed by rearing and release of approximately 5,000 smolts annually (195 mm fl) in April. Incubation and rearing take place at John's Creek pond and the Lilliwaup Hatchery. Smolts are released into John's Creek (trib. to Hamma Hamma) after undergoing natural style rearing/acclimation and/or direct release into the Hamma Hamma River. In addition, captively reared adults are released into the Hamma Hamma watershed as well. This is cooperative program between Long Live the Kings, Hood Canal Salmon Enhancement Group, U.S. Fish and Wildlife Service, NOAA Fisheries, Point No Point Treaty Council, U.S. Forest Service and WDFW. The goal of this program is to evaluate the contribution of supplementation programs of winter steelhead in the Hamma Hamma River using indigenous stock.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids because of the method of collecting eggs (redd pumping), small release numbers, and release location. Competition or predation impacts from this program, if they occur, would occur in the near-shore environment in common with those releases from a large array of programs. The co-managers are conducting studies in estuarine and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts. This program has been reviewed by the Hatchery Scientific Review Group (HSRG) and received a "Proceed with program as designed" recommendation.

Table 59. Summary of risk aversion measures for the Hamma Hamma Winter Steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	No listed species are present within the water source.
Intake Screening	4.2	No listed species are present within the water source.
Effluent Discharge	4.2	No listed species are present within the water source. No NPDES permit is required because the facility produces less than the 20,000 pounds per year criteria set by WDOE as the limit for concern regarding hatchery effluent discharge effects.
Broodstock Collection & Adult Passage	7.9	No listed species are affected due to method of egg collection (Redd pumping).
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Location and size of program reduces potential for predation and competition with listed species in freshwater. Studies will be conducted in estuarine and nearshore areas to evaluate the ecological risks posed by the release of steelhead smolts.

Chum Salmon

George Adams Fall Chum Program: Fall chum salmon are produced at the George Adams Hatchery through an isolated harvest program with an annual release of approximately 5 million at a size of 550 fpp (43 mm fl). Approximately 5,530 adults are required to meet this egg take goal.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids. The life history, feeding habits, and behaviorial attributes of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, fall chum are released from April to limit interactions with listed summer chum. Ongoing and proposed risk aversion measures for this program are summarized in Table 59.

Operational Commitments:

- WDFW will continue to use gametes from fall chum salmon adults volunteering into the George Adams Hatchery for broodstock. Fall chum salmon broodstock collection and spawning takes place from early October to early December while Chinook salmon are entering George Adams Hatchery from early August through mid-September. Therefore, fall chum salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon. No summer chum adults are known to return to the Skokomish River.

- WDFW will limit, as the management intent, annual production of chum for on-station release to a total maximum of 5,000,000 fed fry at a size of 550 fpp (43 mm fl).

- WDFW will release fall chum in April at 550 fpp (43 mmfl). The Summer Chum Conservation Initiative requires fry are released after April 1 to limit interactions with listed summer chumas a protection measure during out-migration (February-March) of listed Hood Canal summer chum. No negative impacts known to occur on listed Chinook salmon juveniles.

Table 60. Summary of risk aversion measures for the George Adams Fall Chum program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring, well and surface water from Purdy Creek is regulated under permits S2-25769a, G2-24645c, S2-05575c, S2-20811c, and S2-23232c. Water used in the hatchery is routed to Purdy Creek immediately below the hatchery.
Intake Screening	4.2	No listed salmonids exist in the water source for this facility.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1019.
Broodstock Collection	7.9	Fall chum salmon voluntarily enter a trap on Purdy Creek in a time period (mid-October to early December) when Chinook salmon are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history, feeding habits, and behaviorial attributes of fall chum salmon are expected to result in limited competitive and predatory interations with listed Chinook salmon. Consistent with the SCCI, fall chum fry are released after April 1 to limit interactions with listed summer chum.

McKernan Fall Chum Program: Fall chum salmon are produced at the McKernan Hatchery through an isolated harvest program with an annual release of approximately 10 million at a size of 450-550 fpp (44 - 43 mm fl). Approximately 9,170 adults are required to meet the egg take goal.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids. The life history, feeding habits, and behaviorial attributes of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, fall chum are released in April to limit interactions with listed summer chum. Ongoing and proposed risk aversion measures for this program are summarized in Table 60.

Operational Commitments:

- WDFW will continue to use gametes from fall chum salmon adults volunteering into the McKernan Hatchery for broodstock. .Fall chum salmon broodstock collection and spawning takes place from early October to early December while Chinook salmon are entering McKernan Hatchery from early August through mid-September. Therefore, fall chum salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon. No summer chum adults are known to return to the Skokomish River.

- WDFW will limit, as the management intent, annual production of chum for on-station release to a total maximum of 10.0 million fed fry at a size of 450-550 fpp (44 - 43 mm fl).

- WDFW will release fall chum in April. The Summer Chum Conservation Initiative requires that no hatchery releases in Hood Canal occur prior to April 1 as a protection measure during out-migration (February-March) of listed Hood Canal summer chum. No negative impacts are known to occur on listed Chinook salmon juveniles.

Table 61. Summary of risk aversion measures for the McKernan Fall Chum program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring, well and surface water from Weaver Creek is regulated under permits: S2-24943 and S2-24595. Water used in the hatchery is routed to Weaver Creek immediately below the hatchery.
Intake Screening	4.2	No listed salmonids exist in the water source for this facility.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1036.
Broodstock Collection	7.9	Fall chum salmon voluntarily enter a trap on Weaver Creek in a time period (mid-October to early December) when Chinook salmon are not typically present.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history, feeding habits, and behaviorial attributes of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, fall chum are released from in April to limit interactions with listed summer chum.

Skokomish Tribal Hatchery Fall Chum Salmon:
The purpose of this program is to provide fishing opportunity for fall chum salmon, promoting the stability and viability of treaty and non-treaty fisheries. The program, which began in 1977 with Quilcene River brood stock, is operated by the Skokomish Tribe. The production objectives for this program are to release 1 million unfed (or partially fed) fry and 1.5 million fed fry from Enetai Creek. Approximately 2,250 brood fish are collected annually during late November, December, and early January. Fish returning to Enetai Creek enter the hatchery holding facilities through a weir at the mouth of the creek. Fish are spawned and eggs are incubated at tribal hatchery. Eyed eggs are

incubated in Netarts incubators and transferred to seven circular fiberglass rearing ponds in middle to late March. Unfed (or partially fed) fry are released from the hatchery in April at 900-1250 fpp (approximately 38mm-41mm fl). Fed fry are released in late April at 400 fpp (51mm fl).

The effects of this program on listed Chinook salmon and summer chum salmon are minimal. Chinook salmon and summer chum salmon do not spawn in Enetai Creek. The closest summer chum salmon spawning occurs in Lilliwaup Creek, which is eight miles to the north. Chinook salmon do occur in the Skokomish River immediate south of Enetai Creek. Enetia fall chum salmon may interact with summer chum and Chinook salmon during migration through the Hood Canal estuary. Brood stock collection has little negative impact on summer chum and Chinook salmon. The lack of a close spawning population of summer chum and earlier run-timing of summer chum salmon (August to October) and fall Chinook salmon (mid September through October) mean that they are rarely encountered during brood stock collection. It is possible that fall chum salmon returning to the Skokomish Tribal Hatchery could stray into a summer chum stream, spawn, and disrupt incubation of summer chum salmon eggs. The impacts of this appear unlikely, however, and were addressed in the Summer Chum Salmon Conservation Initiative (WDFW and Point No Point Tribes 2000). Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Potential competition between chum salmon and Chinook salmon from mid-Puget Sound stocks in the nearshore is minimized by releasing the chum salmon earlier than Chinook salmon outmigration and close to the estuary where they can disperse quickly over a large area. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare.

Hoodsport Fall Chum Program: Fall chum salmon are produced at the Hoodsport Hatchery through an isolated harvest program with an annual release of approximately 15 million at a size of 450 fpp (44 mm fl). Approximately 15,000 adults (1:1 spawning) are required to meet the egg take goal of 15.7 million.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids. The life history, feeding habits, and behavioral attributes of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, fall chum are released in April to limit interactions with listed summer chum. Ongoing and proposed risk aversion measures for this program are summarized in Table 61.

Operational Commitments:

- WDFW will continue to use gametes from fall chum salmon adults volunteering into the Hoodsport Hatchery for broodstock. .Fall chum salmon broodstock collection and spawning takes place from early October to early December while Chinook salmon are entering Hoodsport Hatchery from early August through mid-September. Therefore, fall chum salmon broodstock collection is expected to have a minimal impact on listed Chinook salmon. The summer chum population in Finch Creek is believed to be extinct.

- WDFW will limit, as the management intent, annual production of chum for on-station release to a total maximum of 15.0 million fed fry at a size of 450 fpp (44 mm fl).

- WDFW will release fall chum in April. The Summer Chum Conservation Initiative requires that no hatchery releases in Hood Canal occur prior to April 1 as a protection measure during out-migration (February-March) of listed Hood Canal summer chum. No negative impacts known to occur on listed Chinook salmon juveniles.

Table 62. Summary of risk aversion measures for the Hoodsport Fall Chum program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring, well and surface water from Finch Creek is regulated under permits: S2-10052, S2-16438 and S2-20588. Water used in the hatchery is routed to Finch Creek immediately below the hatchery..
Intake Screening	4.2	No listed salmonids exist in the water source for this facility.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1011.
Broodstock Collection	7.9	The PSTRT has not identified Finch Creek as a Chinook salmon population and the summer chum population is believed to be extinct.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history, feeding habits, and behavioral attributes of fall chum salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, fall chum are released in April to limit interactions with listed summer chum.

Pink Salmon

Hoodsport Pink Salmon Program: Pink salmon are produced at the Hoodsport Hatchery through an isolated harvest program with an annual release of approximately 1.0 million fed fry. This program has been reduced by 68% from the 1993 through 2001 average release of 3.1 million. The Hoodsport program egg take goal is 1.3 million pink salmon eggs. The number of adults (in odd numbered brood years) required to meet the egg take goal would be about 1,733 (1:1), depending on fecundity.

Summary of Program Evaluation and Risk Aversion Measures: This program poses minimal risks to listed salmonids. The life history, feeding habits, and behavioral attributes of pink salmon are expected to result in limited competitive and predatory interactions withlisted Chinook salmon. Consistent with the SCCI, pinks are released in April to limit interactions with listed summer chum. Ongoing and proposed risk aversion measures for this program are summarized in Table 62.

Operational Commitments:

- WDFW will continue to use gametes from pink salmon adults volunteering into the Hoodsport facility for broodstock. Pink salmon collection and spawning takes place from July through September in odd numbered brood years. The PSTRT has not identified Finch Creek as Chinook salmon population and the summer chum population is believed to be extinct.

- WDFW will limit, as the management intent, annual production of pink salmon for on-station release to a total maximum of 1.0 million fed fry at a size of 450 fpp (44 mm fl). This program has been reduced by 68% from the 1993 through 2001 average release of 3.1 million.

- WDFW will release pink salmon in April. The Summer Chum Conservation Initiative requires that no hatchery releases in Hood Canal occur prior to April 1 as a protection measure during out-migration (February-March) of listed Hood Canal summer chum. No negative impacts known to occur on listed Chinook salmon juveniles.

Table 63. Summary of risk aversion measures for the Hoodsport Pink Salmon program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Usage of spring, well and surface water from Finch Creek is regulated under permits: S2-10052, S2-16438 and S2-20588. Water used in the hatchery is routed to Finch Creek immediately below the hatchery.
Intake Screening	4.2	No listed salmonids exist in the water source for this facility.
Effluent Discharge	4.2	Effluent is regulated through NPDES permit WAG 13-1011.
Broodstock Collection	7.9	The PSTRT has not identified Finch Creek as Chinook salmon population and the summer chum population is believed to be extinct.
Disease Transmission	7.9, 10.11	The program is operated consistent with the comanager's Salmonid Disease Control Policy.
Competition & Predation	10.11	Life history, feeding habits, and behavioral attributes of pink salmon are expected to result in limited competitive and predatory interactions with listed Chinook salmon. Consistent with the SCCI, pink salmon are released from in April to limit interactions with listed summer chum. Program size has been reduced by 68% from the 1993 through 2001 average release of 3.1 million.

Quilcene and Dabob Bays

Ecological Context for Hatchery Production
The Big Quilcene and Little Quilcene rivers are the main drainages into northwestern Hood Canal. Like the other rivers on this side of Hood Canal, these rivers arise in the Olympic Mountains and tumble through rugged, steep-walled valleys before their gradients lessen and the valleys broaden out. The Big Quilcene is accessible to anadromous fish for nine of its 19 miles and the Little Quilcene is accessible for seven of its 12 miles.

At least four stocks of anadromous salmonids originate in this region. No self-sustaining population of listed Chinook salmon is unique to this area, however. Local coho salmon and summer chum salmon stocks are most vulnerable to extinction (Table 63). The status of other stocks is healthy or unknown. Hatchery programs occur on three of these stocks (Table 63) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural populations.

Table 64. Anadromous salmonid species, stocks, stock status, and hatchery strategies in mid Hood Canal, Quilcene, and Dabob bays. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Chinook salmon	Mid-Hood Canal[6]	Threatened[2]	Integrated recovery
Coho salmon	Quilcene/Dabob Bays	Depressed[3]	Isolated harvest
Chum salmon	Big/Little Quilcene summer Quilcene late fall	Threatened[2] Healthy[3]	Integrated recovery -
Steelhead	Quilcene/Dabob Bays winter	Unknown[3]	-
Cutthroat trout	West Hood Canal	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SASSI 1992 (WDFW et al. 1993)
[4] 1998 SaSI status (WDFW 1998)
[5] 2000 SaSI status (WDFW 2000)
[6] Puget Sound Technical Recovery Team

The U.S. Fish and Wildlife Service (USFWS) and the Skokomish Tribe have hatchery facilities in this region. The USFWS operates the Quilcene National Fish Hatchery on the Big Quilcene River for conservation of summer chum and harvest augmentation of coho salmon. The Skokomish Tribe operates the Quilcene Bay coho salmon net pen at the southeast end of Quilcene Bay near Fisherman's Point. Hatchery programs for summer chum are described in the Summer Chum Salmon Conservation Initiative (WDFW and Point No Point Tribes 2000).

Coho Salmon

<u>Quilcene Coho Salmon Net Pens</u>: The purpose of this rearing program is to provide fishing opportunity for coho salmon, promoting the stability and viability of treaty and non-treaty fisheries. The program began in 1986 and is a cooperative effort between the Skokomish Tribe, WDFW, and the U.S. Fish and Wildlife Service (USFWS). The production objective of this program is to release 200,000 yearling coho salmon into Quilcene Bay. Brood stock for this program are collected and spawned by the USFWS at the Quilcene National Fish Hatchery where the progeny are incubated, hatched, and reared to smolt stage (see Quilcene National Fish Hatchery HGMP for details). Smolts are transferred to the net pens in January where the fish are acclimated and reared until April or May when they are released directly into Quilcene Bay. The Skokomish Tribe operates the net pen and the feed is provided by WDFW. Fish are released at a size of approximately15 fpp (143mm fl).

A variety of measures reduce the impacts of this program on listed summer chum salmon and Chinook salmon. The program does not impact Chinook salmon or summer chum salmon by brood stock collection because it does not collect its own brood stock (see USFWS Quilcene National Fish Hatchery HGMP). Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition and predation of coho salmon from Quilcene Bay net pens may impact juvenile Chinook salmon and summer chum salmon, however, after they are released into the estuary. Summer chum salmon occur in the Big and Little Quilcene rivers that enter Quilcene Bay and the closest Chinook salmon spawn in the Dosewallips River approximately seven miles to the south. Impacts on Chinook salmon have not been measured, but may be limited because the net pen is removed from major areas of natural production in the Dosewallips and farther south. In addition, production objectives for the program have been reduced from releases of 400,000 annually in 1990 to 200,000, which reduced potential interactions. To limit negative impacts on summer chum, the program follows risk aversion measures described in the Summer Chum Salmon Conservation Initiative (WDFW and Point No Point Tribes 2000), including releasing the fish after April 15.

Eastern Hood Canal

Ecological Context for Hatchery Production

This region includes the rivers, streams, and inlets of the western shore of the Kitsap Peninsula that drain into Hood Canal. The Union, Dewatto, and Tahuya rivers are the largest of these. Together they provide approximately 130 miles of stream.

At least 15 stocks of four species of salmon are characteristic of this part of Hood Canal (Table 64). No independent, self-sustaining populations of Chinook salmon occur in this region, although Chinook salmon may occur intermittently or in low numbers in the larger rivers. Many of these streams once supported healthy populations of summer chum salmon, but these populations are now threatened or extinct. Abundances of winter steelhead populations in the larger rivers are also depressed. Hatchery programs occur on four of these stocks (Table 64) and are focused on either assisting in recovering the natural population or providing harvest that cannot be supported by the natural populations.

Similar to many other lowland areas of the Puget Sound, agriculture, residential development, and timber harvest have altered freshwater and estuarine habitats for salmon. Because stream flows in this region are dominated by rainfall and not snow melt from higher elevation snow pack areas, they are subject to low summer flows. Historically, groundwater, wetlands, and beaver ponds have helped maintain summer flows for fish, but logging, agriculture, and development have removed riparian cover, filled wetlands, destabilized banks and increased erosion and sediments in streams, and decreased water quality. With the conversion of forest land to residential and commercial development, less flow is available to sustain salmon rearing during the dry months. Non-native warm-water fishes have been introduced into many streams and lowland lakes where they may prey on or compete with salmonids. Culverts, screens, and dams may block access to spawning areas. Nearshore habitat has been altered by dikes and filling, roads, and residential development.

Table 65. Anadromous salmonid species, stocks, stock status, and hatchery strategies in eastern Hood Canal. Status of hatchery stocks used in isolated programs not evaluated (NE).

Species	Stock	Status	Hatchery Strategy
Coho salmon	Northeast Hood Canal	Healthy[3]	-
	Dewatto	Healthy[3]	-
	Southeast Hood Canal	Healthy[3]	-
Chum salmon	Union River summer	Threatened[2]	Integrated recovery
	Tahuya River summer	Threatened[2]	Reintroduction[6]
	Dewatto summer	Threatened[2]	Potential reintroduction[6]
	Big Beef Creek summer	Threatened[2]	Reintroduction
	Northeast Hood Canal fall	Healthy[3]	-
	Port Gamble fall	Hatchery	Isolated harvest
	Dewatto fall	Healthy[3]	-
	Southeast Hood Canal fall	Healthy[3]	-

Steelhead	Dewatto winter Tahuya winter Union winter	Depressed[3] Depressed[3] Unknown[3]	- - -
Cutthroat trout	East Hood Canal	Unknown[5]	-

[1] WDFW treated both species as a single complex until genetic studies identify the species. Bull trout are listed as threatened under the Endangered Species Act.
[2] Endangered Species Act
[3] SaSI 2002 (http://wdfw.wa.gov/mapping/salmonscape/). Tribes have not yet fully reviewed this assessment.
[4] 1998 SaSI (WDFW 1998)
[5] 2000 SaSI (WDFW 2000)
[6] Union stock

Several hatchery facilities exist in this region. The Port Gamble S'Klallam Tribe operates the Port Gamble Hatchery (fall chum salmon(and Net Pens (coho salmon) in Port Gamble Bay. The University of Washington operates Big Beef Creek Hatchery on Big Beef Creek north of the town of Seabeck, Washington. The HCSEG and volunteers operate small fall chum facilities on four streams in southeastern Hood Canal.

Coho Salmon

Port Gamble Coho Salmon Net Pens: The purpose of this rearing program is to provide fishing opportunity for coho salmon, promoting the stability and viability of treaty and non-treaty fisheries. The program, which began in 1981, is a cooperative effort between the Skokomish Tribe, WDFW, and the U.S. Fish and Wildlife Service (USFWS). The production objective of this program is to release 400,000 yearling coho salmon in Port Gamble Bay. Brood stock for this program are collected and spawned by the USFWS at the Quilcene National Fish Hatchery. Eggs are incubated, hatched, and the fry are reared at WDFW's George Adams Hatchery until the smolt stage (see Quilcene National Fish Hatchery and WDFW's George Adams Hatchery HGMPs for details). Smolts are transferred to the net pens in January where the fish are acclimated and reared until April or May when they are released directly into Port Gamble Bay. The Port Gamble S'Klallam Tribe operates the net pen and the fish food is provided by WDFW. Fish are released at a size of approximately10 fpp (164mm fl).

A variety of measures reduce the impacts of this program on listed summer chum salmon and Chinook salmon. The program does not impact Chinook salmon or summer chum salmon by brood stock collection because it does not collect its own brood stock. Potential disease impacts of the program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Competition and predation of coho salmon from the net pens may impact juvenile Chinook salmon and summer chum salmon, however, after they are released into the estuary. The closest summer chum salmon streams are Big Beef Creek (20 miles away), the Big and Little Quilcene rivers (24 miles away), and Chimacum Creek (17 miles away) in Admiralty Inlet. The closest Chinook salmon stream is the Dosewallips River (22 miles away. Impacts have not been measured, but they may be limited because the net pen is removed from major areas of natural production allowing fish time and space to disperse. To limit negative impacts on summer chum, the program follows risk aversion measures described in the Summer Chum Salmon Conservation Initiative (WDFW and Point No Point Tribes 2000), including releasing the fish after April 15.

Chum Salmon

Port Gamble Hatchery Fall Chum: The purpose of this rearing program is to provide fishing opportunity for chum salmon, promoting the stability and viability of treaty and non-treaty fisheries. The program, which began in 1977 using eggs from WDFW Finch Creek stock, is operated by the Port Gamble S'Klallam Tribe and now uses brood stock returning to the Port Gamble hatchery. The production objective of this program is to release 950,000 fry into Little Boston Creek, which flows into Port Gamble Bay. Approximately 1,300 brood fish are collected at the Port Gamble Hatchery after they voluntarily enter through a weir at the mouth of Little Boston Creek in November and December. Fish are spawned and eggs are incubated at the Port Gamble Hatchery. Hatched fry are transferred from incubation trays to raceways in early March. Fish are released as fry at 400-450 fish/pound in April and May in the evening on a high tide to encourage rapid fry migration and dispersal.

The effects of this program on listed Chinook and summer chum salmon are minimal. The potential impacts from brood stock collection are minimal. Adult Chinook salmon and summer chum salmon do not return to creeks feeding Port Gamble Bay. The closest summer chum salmon streams are Big Beef Creek (20 miles away), the Big and Little Quilcene rivers (24 miles away), and Chimacum Creek (17 miles away) in Admiralty Inlet. The closest Chinook salmon stream is the Dosewallips River (22 miles away). The lack of nearby spawning populations of summer chum and the earlier run-timing of summer chum salmon (August to October) and fall Chinook salmon (mid September through October) means that they are almost never encountered during brood stock collection. It is possible that fall chum salmon from the Port Gamble Hatchery could stray into a summer chum salmon stream, spawn, and disrupt incubation of summer chum salmon eggs. The impacts of this appear unlikely, however, and were addressed in the Summer Chum Salmon Conservation Initiative (WDFW and Point No Point Tribes 2000). Potential disease impacts of the hatchery program are controlled through regular monitoring by professional pathologists from the Northwest Indian Fisheries Commission and treatment if necessary. Potential competition between fall chum salmon and summer chum salmon in the nearshore is minimized by releasing the fall chum salmon after April 1 (after the summer chum outmigration) and earlier than Chinook salmon outmigration. Release numbers have been reduced nearly 60% from a high of 2.3 million in 1988 to current levels. In addition, releases are close to the estuary where the fish can disperse quickly over a large area. Because of life history and developmental differences, predation by juvenile chum on Chinook salmon would be extremely rare.

EFFECTS OF ACTIONS

Review of Potential Adverse Effects

The scientific literature indicates that hatcheries may have adverse effects on wild Chinook populations as well as potential benefits. These impacts may be reduced or eliminated by improved management and hatchery practices developed and tested by adaptive management. The primary potential for adverse effects of non-Chinook programs may come from ecological impacts, such as loss of habitat, competition, predation, and disease. These potential impacts arise from a variety of interacting sources, including the physical layout and operation of the hatchery facility, hatchery practices (how fish are collected, reared, and released), and management decisions about how hatcheries are used. Not all impacts occur everywhere and often the potential adverse effects of one kind arise because of actions taken to minimize impacts of another kind. These potential effects are reviewed in the scientific literature (e.g. Busack and Currens, 1995, Campton, 1995), in NMFS consultation documents (NMFS, 2001), the biological assessment of federally funded Puget Sound tribal hatchery programs by the Bureau of Indian Affairs (BIA, 1999), and brief descriptions are also included here.

Impacts of Hatchery Facilities

Hatchery facilities can have demographic impacts on wild fish. The operation of hatchery facilities can directly affect abundance and survival of wild fish through physical injury or mortality resulting from fish being impinged at water intake locations. Hatcheries facilities may indirectly affect wild fish by altering water quality and quantity in the stream where the hatchery is located. Water withdrawals from wild Chinook spawning and rearing areas for hatchery operations can diminish stream flow in the area of the stream below the water intake to where the outflow from the hatchery rejoins the stream. If flow is diminished enough, it can impede migration and affect spawning behavior of fish in the stream. Water withdrawals may also affect other stream-dwelling organisms on which wild fish feed, leading to decreased growth and displacement. Hatchery effluents may change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra, 1991). These impacts can be addressed by modernizing and upgrading hatchery facilities to prevent impingement at water intake locations, scaling water use and discharge to allow migration of fish, and treating effluents.

Impacts of Brood Stock Collection

Brood stock collection may have a negative demographic impact on wild salmon. Hatcheries may collect threatened or endangered fish in the process of collecting non-Chinook stocks. Hatcheries that collect returning hatchery fish for brood stock may also incidentally collect wild listed fish, particularly if the run timing overlaps significantly and if there are inadequate mechanisms to separate and pass wild-origin Chinook upstream. In addition, weirs or barriers that may be used to trap brood stock may blocks or hinder upstream migration of naturally spawning fish, leading to delayed upstream migration, displaced spawning, increased stress, or injury from handling or attempting to pass the weir. In most cases the potential of broodstock collection overlap between hatchery program fish and listed Chinook is small or non existent due to the difference in run timing. Improving hatchery facilities, and handling fish in ways that reduce stress and injury will minimize the risks to listed Chinook when and where species overlaps may occur.

Genetic Effects

Genetic effects of non-Chinook programs on Chinook salmon are not likely. Interspecific hybridization has rarely been documented in the literature and is not a serious risk normally considered a factor in the maintenance of genetic integrity of Chinook stocks. Other aspects of hatcheries operations, such as water quality, barriers, intakes and broodstock collection that exert a direct or subtle selective pressure on one segment of a natural population may, over time, have the effect of changing the natural genetic of such characters as run timing, spawning date or out-migration. The sources and affects of operational effects are not well known or documented. These impacts can be addressed by developing and using rearing and release procedures that minimize spatial and temporal overlap with listed species, using modern brood stock collection and sorting facilities, and by minimizing the intentional or unintentional delay of adult and juvenile migrants at the hatchery.

Ecological Effects

Fish produced from the programs described in this RMP interact with the biotic and abiotic components of the freshwater, estuarine, and marine salmonid ecosystem through a complex web of short and long-term processes. The complexity of this web means that secondary or tertiary interactions (both positive and negative) with listed species could occur in multiple time periods, and that evaluation of the net effect can be difficult.

These ecological interactions may be grouped into five general categories: predation, competition, displacement (a form of competition for space), disease, and nutrient enhancement. Since program specific evaluations of these potential ecological interactions are limited, we have attempted to briefly summarize the existing empirical and theoretical analyses with the intent of:

1) assessing the potential ecological benefits or risks posed by the programs;
2) identifying potential risk containment strategies; and
3) prioritizing research, monitoring, and evaluation needs.

Recent reviews by Fresh (1997), Flagg et al. (2000), and Stockner (2003) can be consulted for additional information. NMFS (2002) also provides an extensive review with application to ESA permitting of artificial production programs.

Predation – Freshwater Environment

Coho and steelhead released from hatchery programs may prey upon listed species of salmonids, but the magnitude of predation will depend upon the characteristic of the listed population of salmonids, the habitat in which the population occurs, and the characteristics of the hatchery program (e.g., release time, release location, number released, and size of fish released). The site specific nature of predation, and the limited number of empirical studies that have been conducted, make it difficult to predict the predation effects of any specific hatchery program. We are unaware of any studies that have empirically estimated the predation risks to listed species posed by the program described in this HGMP.

In the absence of site-specific empirical information, the identification of risk factors can be a useful tool for reviewing hatchery programs while monitoring and research programs are developed and implemented. Risk factors for evaluating the potential for significant predation include the following:

Environmental Characteristics. Water clarity and temperature, channel size and configuration, and river flow are among the environmental characteristics that can influence the likelihood that predation will occur (see SIWG (1984) for a review). The SIWG (1984) concluded that the potential for predation is greatest in small streams with flow and turbidity conditions conducive to high visibility.

Relative Body Size. The potential for predation is limited by the relative body size of fish released from the program and the size of prey. Generally, salmonid predators are thought to prey on fish approximately 1/3 or less their length (USFWS 1994), although coho salmon have been observed to consume juvenile Chinook salmon of up to 46% of their total length (Pearsons et al. 1998). The lengths of juvenile migrant Chinook salmon originating from natural production have been monitored in numerous watersheds throughout Puget Sound, including the Skagit River , Stillaguamish River, Bear Creek, Cedar River, Green River, Puyallup River, and Dungeness River. The average size of migrant Chinook salmon is typically 40mm or less in February and March, but increases in the period from April through June as emergence is completed and growth commences (Table 65). Assuming that the prey item can be no greater than 1/3 the length of the predator, Table 65 can be used to determine the length of predator required to consume a Chinook salmon of average length in each time period. The increasing length of natural origin juvenile Chinook salmon from March through June indicates that delaying the release hatchery smolts of a fixed size will reduce the risks associated with predation.

Date of Release. The release date of juvenile fish for the program can influence the likelihood that listed species are encountered or are of a size that is small enough to be consumed. The most extensive studies of the migration timing of naturally produced juvenile Chinook salmon in the Puget Sound ESU have been conducted in the Skagit River, Bear Creek, Cedar River, and the Green River. Although distinct differences are evident in the timing of migration between watersheds, several general patterns are beginning to emerge:

1) Emigration occurs over a prolonged period, beginning soon after enough emergence (typically January) and continuing at least until July;

2) Two broad peaks in migration are often present during the January through July time period; an early season peak (typically in March) comprised of relatively small Chinook salmon (40-45mm), and a second peak in mid-May to June comprised of larger Chinook salmon;

3) On average, over 80% of the juvenile Chinook have migrated past the trapping locations after statistical week 23 (usually occurring in the first week of June).

Release Location and Release Type. The likelihood of predation may also be affected by the location and type of release. Other factors being equal, the risk of predation may increase with the length of time the fish released from the artificial production program are commingled with the listed species. In the freshwater environment, this is likely to be affected by distribution of the listed species in the watershed, the location of the release, and the speed at which fish released from the program migrate from the watershed.

Coho salmon and steelhead released from western Washington artificial production programs as smolts have typically been found to migrate rapidly downstream. Data from Seiler et al. (1997; 2000) indicate that coho smolts released from the Marblemount Hatchery on the Skagit River migrate approximately 11.2 river miles day. Steelhead smolts released on station may travel even more rapidly – migration rates of approximately 20 river miles per day have been observed in the Cowlitz River (Harza 1998). However, trucking fish to off station release sites, particularly release

Table 66. Average length by statistical week of natural origin juvenile Chinook salmon migrants captured in traps in Puget Sound watersheds. The minimum predator length corresponding to the average length of Chinook salmon migrants, assuming that the prey can be no greater than 1/3 the length of the predator, are provided in the final row of the table. (NS: not sampled.)

Watershed	Statistical Week										
	16	17	18	19	20	21	22	23	24	25	26
Skagit [1] 1997-2001	43.2	48.3	50.6	51.7	56.1	59.0	58.0	60.3	61.7	66.5	68.0
Stillaguamish [2] 2001-2002	51.4	53.5	55.7	57.8	60.0	62.1	64.2	66.4	68.5	70.6	72.8
Cedar [3] 1998-2000	54.9	64.2	66.5	70.2	75.3	77.5	80.7	85.5	89.7	99.0	113
Green [4] 2000	52.1	57.2	59.6	63.1	68.1	69.5	NS	79.0	82.4	79.4	76.3
Puyallup [5] 2002	NS	NS	NS	66.2	62.0	70.3	73.7	72.7	78.7	80.0	82.3
Dungeness [6] 1996-1997	NS	NS	NS	NS	NS	NS	NS	NS	77.9	78.8	81.8
All Systems Average Length	50.4	55.8	58.1	61.8	64.3	67.7	69.2	72.8	76.5	79.0	82.4
Minimum Predator Length	153	169	176	187	195	205	210	221	232	239	250

Sources:
[1] Data are from Seiler et al. (1998); Seiler et al. (1999); Seiler et al. (2000); Seiler et al. (2001), and Seiler et al. (2002)..
[2] Data are from regression models presented in Griffith et al. (2001) and Griffith et al. (2003).
[3] Data are from Seiler et al. (2003).
[4] Data are from Seiler et. (2002).
[5] Data are from Samarin and Sebastian (2002).
[6] Data are from Marlowe et al. (2001).

Table 67. Average cumulative proportion of the total number of natural origin juvenile Chinook salmon migrants estimated to have migrated past traps in Puget Sound watersheds.

Watershed	Statistical Week										
	16	17	18	19	20	21	22	23	24	25	26
Skagit [1] 1997-2001											
Bear [2] 1999-2000	0.26	0.27	0.28	0.32	0.41	0.52	0.73	0.84	0.92	0.96	0.97
Cedar [2] 1999-2000	0.76	0.76	.0.76	0.77	0.79	0.80	0.82	0.84	0.87	0.88	0.90
Green [3] 2000	0.63	0.63	0.64	0.69	0.77	0.79	0.84	0.86	0.88	0.98	1.00
All Systems Average											

Sources:
[1] Data are from Seiler et al. (1998); Seiler et al. (1999); Seiler et al. (2000); Seiler et al. (2001), and Seiler et al. (2002)..
[2] Data are from Seiler et al. (2003).
[3] Data are from Seiler et. (2002).

Table 68. Summary of travel speeds for steelhead smolts for several types of release strategies.

Location	Release Type	Migration Speed (river miles per day)	Source
Cowlitz River	Smolts, on station	21.3	Harza (1998)
Kalama River	Trucked from facility located within watershed in which fish were released.	4.4	Hulett (pers. comm.)
Bingham Creek	Trucked from facility located outside of watershed in which fish were released.	0.6	Seiler et al. (1997)
Stevens Creek	Trucked from facility located outside of watershed in which fish were released.	0.5	Seiler et al. (1997)
Snow Creek	Trucked from facility located outside of watershed in which fish were released.	0.4	Seiler et al. (1997)

sites located outside of the watershed in which the fish have been reared, may slow migrations speeds (Table 3).

Number Released. Increasing the number of fish released from an artificial production program may increase the risk of predation, although competition between predators for prey may eventually limit the total consumption (Peterman and Gatto 1978).

Predation – Marine Environment

Although predation may occur in marine waters, we are unaware of any studies that have empirically estimated the predation risks to listed species posed by the program described in this HGMP. NMFS (2002) reviewed existing information on the risks of predation in the marine environment posed by artificial production programs and concluded:

> "1) Predation by hatchery fish on natural-origin smolts or sub-adults is less likely to occur than predation on fry. Coho and Chinook salmon, after entering the marine environment, generally prey upon fish one-half their length or less and consume, on average, fish prey that is less than one-fifth of their length (Brodeur 1991). During early marine life, predation on natural origin Chinook, coho, and steelhead will likely be highest in situations where large, yearling-sized hatchery fish encounter sub-yearling fish or fry (SIWG 1984)."
>
> "2) However, extensive stomach content analysis of coho salmon smolts collected through several studies in marine waters of Puget Sound, Washington do not substantiate any indication of significant predation upon juvenile salmonids (Simestad and Kinney 1978)."

"3) Likely reasons for apparent low predation rates on salmon juveniles, including Chinook, by larger Chinook and other marine predators are described by Cardwell and Fresh (1979). These reasons included: 1) due to rapid growth, fry are better able to elude predators and are accessible to a smaller proportion of predators due to size alone; 2) because fry have dispersed, they are present in low densities relative to other fish and invertebrate prey; and 3) there has either been learning or selection for some predator avoidance."

Competition

Although competition may occur in marine waters, no studies have documented an overall negative effect of competition on listed species posed by program described in this HGMP. Studies conducted in other areas indicate that this program is likely to pose a minimal risk of competition:

1) As discussed above, coho salmon and steelhead released from hatchery programs as smolts typically migrate rapidly downstream. The SIWG (1984) concluded that "migrant fish will likely be present for too short a period to compete with resident salmonids."

2) NMFS (2002) noted

> "..where interspecific populations have evolved sympatrically, Chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions with coho salmon (Nilsson 1967; Lister and Genoe 1970; Taylor 1991). Along with the habitat differences exhibited by coho and steelhead, they also show differences in foraging behavior. Peterson (1966) and Johnston (1967) reported that juvenile coho are surface oriented and feed primarily on drifting and flying insects, while steelhead are bottom oriented and feed largely on benthic invertebrates."

3) Flagg et al. (2000) concluded

> "By definition, hatchery and wild salmonids will not compete unless they require the same limiting resource. Thus, the modern enhancement strategy of releasing salmon and steelhead trout as smolts markedly reduces the potential for hatchery and wild fish to compete for

resources in the freshwater rearing environment. Miller (1953), Hochachka (1961), and Reimers (1963), among others, have noted that this potential for competition is further reduced by the fact that many hatchery salmonids have developed different habitat and dietary behavior than wild salmonids." Flagg et al (2000) also stated "It is unclear whether or not hatchery and wild Chinook salmon utilize similar or different resources in the estuarine environment."

4) Fresh (1997) noted

> "Few studies have clearly established the role of competition and predation in anadromous population declines, especially in marine habitats. A major reason for the uncertainty in the available data is the complexity and dynamic nature of competition and predation; a small change in one variable (e.g., prey size) significantly changes outcomes of competition and predation. In addition, large data gaps exist in our understanding of these interactions. For instance, evaluating the impact of introduced fishes is impossible because we do not know which nonnative fishes occur in many salmon-producing watersheds. Most available information is circumstantial. While such information can identify where inter- or intra specific relationships may occur, it does not test mechanisms explaining why observed relations exist. Thus, competition and predation are usually one of several plausible hypotheses explaining observed results."

Displacement

The large volumes of juvenile hatchery salmon released may displace rearing wild Chinook juveniles from stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al., 1994). The relative size of affected wild Chinook when compared to hatchery fish, as well as the abundance of hatchery fish encountered, also will determine the degree to which wild fish are displaced (Steward and Bjornn 1990). Wild fish may be competitively displaced by hatchery fish early in life especially when hatchery fish are more numerous, of equal or greater size, and if non-migratory hatchery fish have taken up residency before wild fry emerge from redds.

These impacts can be reduced by developing and using rearing and release strategies that minimize competition and predation between wild and hatchery origin fish by assuring temporal and spatial segregation of hatchery and wild populations. Release strategies should:

1) Emphasize smolt releases which will out-migrate quickly.
2) Avoid non-migrant smolts which may compete directly with listed stocks.
3) Release smolts at a time when out-migration overlap with listed stocks is minimized.
4) Release smolts at a size which minimizes their ability to consume listed stocks.
5) Allow for adaptive management as research, monitoring and evaluations dictate.

Disease

Pathogens are not unique to hatcheries. The pathogens responsible for fish diseases are present in both hatchery and natural populations. Consequently, determining the primary source of the pathogen affecting wild fish can be problematic (Williams and Amend, 1976, Hastein and Lindstad, 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because higher rearing densities of fish in the hatcheries may stress fish and lower immune responses. Under natural, low-density conditions, most pathogens do not lead to disease outbreaks. When fish disease outbreaks do occur, they are often triggered by stressful hatchery rearing conditions, or by a deleterious change in the environment (Saunders, 1991). Under certain conditions, hatchery effluent has the potential to transport fish pathogens out of the hatchery, where natural fish may be exposed to infection. Interactions between hatchery fish and natural fish in the environment may also result in the transmission of pathogens, if either the hatchery or natural fish are harboring a fish disease. This latter impact may occur in tributary areas where hatchery fish are released andthroughout migration corridors where hatchery and wild fish may interact. These impacts can be addressed by the rearing fish at lower densities, within widely recognized guidelines, continuing well-developed monitoring, diagnostic, and treatment programs already in place, and maintaining risk management guidelines.

Key Actions to Reduce Risk

Hatcheries are technological systems imposed on complex, biological systems. The co-managers' approach to reducing risks in these systems follows the structure outlined by Currens and Busack (1995). They classified actions to reduce risk into two major categories of safeguards: 1) those that provide management reliability (proximate safeguards), which reduce the likelihood of loss due to hazards, and 2) those that provide resilience to natural and hatchery populations by reducing the potential losses associated with hazards should they occur (ultimate safeguards). Both are necessary because in technological systems imposed on complex, biological systems, safeguards can never be completely reliable (i.e. isolate technological hazards from the natural populations), but they can minimize the likelihood of a loss occurring and they can promote rapid recovery (Figure 8). Management methods and practices are examples of safeguards that can provide reliability. Adaptive management, especially the ability to detect changes quickly and to respond, promotes resilience.

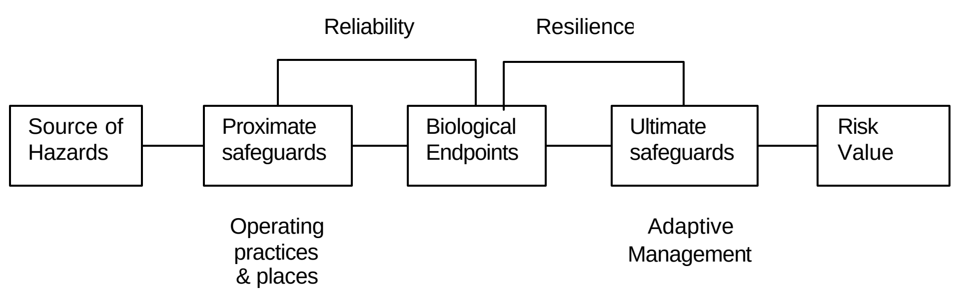


Figure 8. Risk management system adapted from Currens and Busack (1995).

The adaptive management framework for this plan is described in the "Hatchery Reform and Adaptive Management" section. Currens and Busack (1995) classified proximate safeguards into four categories: 1) descriptions of the biological variability, 2) a framework of guidelines, 3) performance and training of technicians expected to implement the guidelines, and adequate logistical support to implement the guidelines. Each of these has subcomponents (Figure 2). For example, guidelines might consist of three kinds: 1) general conservation guidelines, which are based on genetic or ecological first principles, 2) operating guidelines, which are the protocols and procedures that are actually used to implement the conservation guidelines, and 3) decision flow charts that anticipate potential problems and guide a technician or manager to an appropriate, consistent decision when unexpected problems arise. Knowledge of biological variability includes baseline characterization, which may be necessary to design appropriate operating guidelines, and the ability to detect changes, which may be initiating events for failure of a safeguard. Technician performance addresses two sources of risk arise from errors: the ability to complete expected tasks as anticipated (Type I error) and the ability to make an appropriate decision when the unexpected happens (Type II error). Finally, the logistical component includes both availability of appropriate equipment and ability to plan and coordinate the activity (Figure 9).

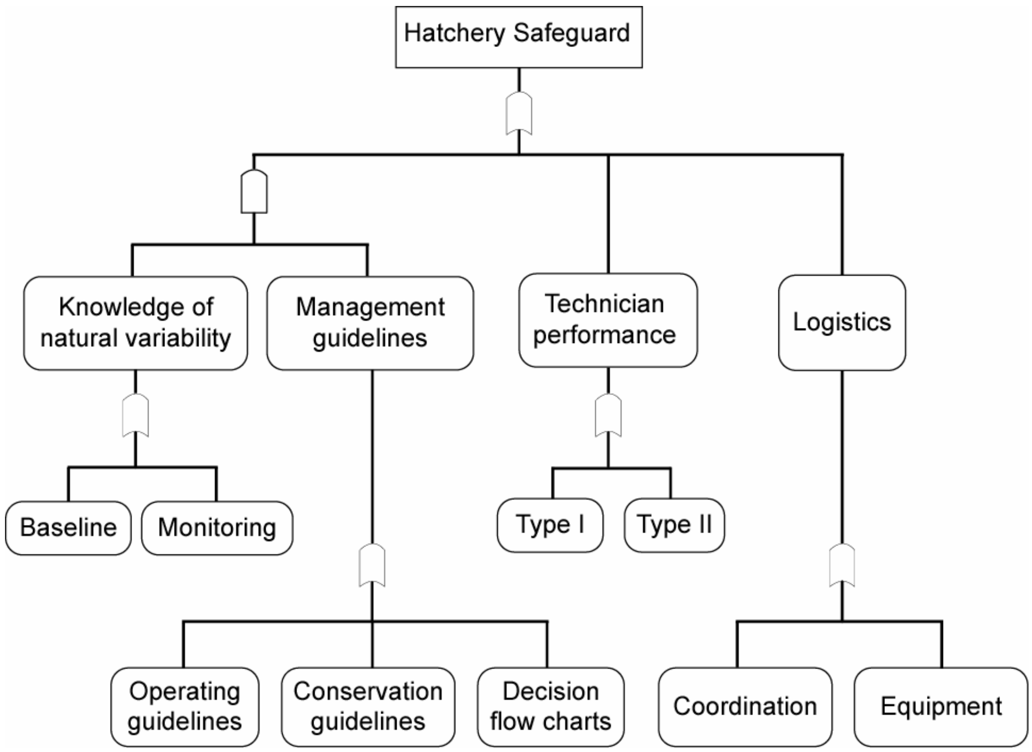


Figure 9. Hierarchy of reliability safeguards for hatcheries from Currens and Busack (in press).

The "Implementation" section of the "Hatchery Reform and Adaptive Management" describes general responses for hatchery management following this classification (Table 3). All of these are important for hatchery reform. Not all of these responses are necessary to address the effects of actions associated with this plan on species protected under the ESA, however. Key responses that focus on monitoring and ecological interactions with listed species are summarized below. Examples of how these have been applied are in descriptions, operating commitments, and tables of risk aversion measures for each individual program. Key actions to reduce risk include

- Marking and recovering tagged hatchery fish
- Reducing production levels where appropriate

- Managing release timing or locations to minimize opportunity for negative ecological interactions with listed species
- Managing fish sizes at release to minimize predation on listed species
- Regular monitoring and treatment of hatchery fish to minimize risk of disease
- Research on fish movement, distributions, habitat use, and predation after leaving the hatchery, which will provide better information for assessing risk and changing hatchery practices.
- Managing effluent discharges from the hatchery
- Improving hatchery facilities and operations of water intake structures, fish passage, or brood stock collection where it could result in impacts on listed species

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APPENDIX A: ARTIFICIAL PRODUCTION GUIDELINES

Table A.1. Guidelines for Integrated-Recovery Programs.

Issue	Guidelines
Natural Population Status	➢ Population should be at significant risk of extinction.
SCALE OF PROJECT	➢ Total production should ▪ be within the freshwater capacity of the system ▪ be large enough to avoid significant loss of genetic variation or increase in inbreeding ▪ take into account unavoidable mortality
INITIATING A PROJECT	➢ Projects should be initiated and continued only if: ▪ The project is estimated to provide a net benefit to the population targeted for recovery; ▪ The project is part of an overall recovery strategy where the causes for the natural population's decline will be corrected in the foreseeable future. A recovery project based on artificial propagation should not be used as a substitute for addressing the causes of a population's decline.
Changing or Terminating the Project	➢ Change or terminate if the project no longer provides a net benefit to the target population.
Measures of Success	➢ Depending on project goals, successful integrated-recovery projects will ▪ Increase the total abundance of the composite natural/hatchery population. ▪ Result in a trend in the number of natural origin recruits (adult progeny of fish that spawned in the wild) that is estimated to be greater than would have been the case without the project; ▪ Produce adult hatchery fish that are similar to wild fish in terms of size, age, morphology, behavior and geographic and temporal spawning distribution; ▪ Maintain the genetic diversity within the management unit or watershed.
Choice of Brood Stock	*Recovery Projects targeting an existing natural population* ➢ Except in extreme circumstances, use only the target population or returning project fish derived from the target population for brood stock Reintroduction Projects ➢ Choose the donor stock that has the greatest similarity tothe stock that was historically present based on (a) genetic lineage, (b) life history patterns, (c) ecology of the originating environment. ▪ First priority is a hatchery population that was recently derived from the extirpated population, or a neighboring population that best meets the similarity requirements. If suitable neighboring populations are depleted, take small numbers of brood stock from several neighboring populations meeting the similarity criteria so as to minimize impacts. ▪ If neighboring populations are not available, use either non-neighboring hatchery or natural populations that best meet the similarity criteria.

Issue	Guidelines
Collection of Brood Stock	➢ Broodstock should be collected in a number and manner that minimizes genetic differences between hatchery and natural components of the population and that minimizes genetic changes to the whole population over time. ▪ Collect proportionally with respect to age, sex, and run-timing over the entire spawning run. ▪ Include all ages. Jacks and precocious parr should be included in proportion to their natural occurrence, taking into account any known differences in fertility and mating success between males of different ages. ➢ Minimize use of hatchery-reared fish for broodstock. ➢ Collected in a manner that minimizes prespawning mortality. ➢ Collect sufficient broodstock to avoid substantial reductions in effective populations size due to genetic amplification effects (see Part 2 - effective population size)
Brood Stock Spawning	➢ Randomize all the matings of fish on a given day. ➢ Do not pool milt prior to fertilization. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining effective population size (see Part 2 - effective population size). ➢ Consider the use of spawning channels or similar methods of allowing the fish to choose their own mates.
Rearing of Fish	➢ Produce fish that are qualitatively similar to natural fish in size, morphology, behavior, physiological status, health and other ecological attributes, while sufficiently increasing survival at all life history stages in the hatchery environment. Emphasize increasing survival when threats to population abundance (extinction) are greatest; increase emphasis on similarity to natural fish as threats to extinction decrease. ▪ Minimize dependence of chemical treatments to maintain fish health. ▪ Rearing should be for the shortest period possible, that also sufficiently enhances post-release survival and that allows the fish to be become imprinted. ▪ Size at release should enhance post-release survival and minimize negative ecological interactions. ➢ Prevent the introduction, spread, or amplification of fish pathogens (*Co-Managers' Fish Disease Control Policy*). ➢ Fish management ▪ Pool fish so that any differences in rearing conditions will affect all families equally. ▪ Culling should be as random as possible. ▪ Limit the number of times fish must be moved during rearing.
Release of Fish	➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Design release strategies to integrate hatchery-reared fish with wild fish of the same life history stage. ➢ When fish are likely to remain in the release area (for example, presmolts or residuals), disperse fish at several locations.

Issue	Guidelines
Release of Fish (cont.)	➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient portion of the fish such that proportion of natural and hatchery fish can be estimated accurately.
Management of Returning Adults	➢ <u>Proportion of project fish spawning naturally with the target population</u>: *If the project meets all other guidelines and is estimated to provide a net benefit to the target natural population* (see Part 2), there is no restriction on the proportion of hatchery fish *of this stock* on the spawning grounds of the target population for the first three generations. After three generations, restrictions should be considered after a detailed program review and risk analysis. ➢ <u>Control of straying to non-target populations</u>: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically distinct populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species and that capture the returning adults as an egg source, or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds where this stock did not historically occur, unless it is a reintroduction project. ➢ Return hatchery-spawned carcasses to local streams for nutrient supplementation following written a application to the co-managers and meeting fish health guidelines.

Table A.2. Guidelines for Integrated-Harvest Projects

Issue	Guidelines
Natural Population Status	➢ Not at significant risk of extinction
Scale of Project	➢ Total hatchery production should be based on meeting harvest objectives, legal agreements, or treaty obligations while keeping within genetic and ecological guidelines. ➢ Duration of project is unrestricted when guidelines are met. ➢ The total abundance of the target population should not exceed the carrying capacity of its habitat.
Changing or Terminating the Project	➢ If population is believed to be at significant risk, terminate or change to integrated-recovery project. ➢ If number of hatchery fish spawning in the target population cannot be limited to acceptable levels (see below), reevaluate the project.
Measures of Success	➢ Successful integrated-harvest projects will ▪ produce fish for harvest; ▪ maintain the number of natural origin recruits (NORs) above the critical/low threshold; ▪ produce adult hatchery fish that are similar to wild fish in terms of size, age, morphology, behavior and geographic and temporal spawning distribution; ▪ maintain the genetic diversity within the watershed and ESU.
Choice of Brood Stock	➢ Use only natural or hatchery origin returns from the target population.
Collection of Brood Stock	➢ Collect in a number and manner that minimizes genetic differences between hatchery and natural components of the population and that minimizes genetic changes to the whole population over time. ▪ Collect numbers of brood stock proportionally with respect to age, sex, and run timing over the entire spawning run. ▪ Include all ages. Jacks and precocious parr should be included in proportion to their natural occurrence. ▪ Ideally, a substantial proportion of the brood stock each generation should be natural origin fish. ➢ Brood stock should be collected to minimize prespawning mortality. ➢ Limit the number of fish collected for brood stock so that the number remaining to spawn naturally will meet minimum population size recommendations or escapement goals. (If it is impossible to meet this guideline, consider whether the objective of this project would be better met by an integrated-recovery project or an isolated-harvest project.)

Issue	Guidelines
Brood Stock Spawning	➢ Randomize all the matings of fish that are ready for spawning on a given day. ➢ Do not pool milt prior to fertilization. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining the variance effective population size.
Rearing of Fish	➢ Produce fish that are as similar to natural fish as possible in size, morphology, behavior, physiological status, health and other ecological attributes, balanced against the propagation goals of the project. ▪ Minimize dependence of chemical treatments to maintain fish health. ▪ Length of rearing should be the shortest period possible, balanced to ensure sufficient post-release survival and imprinting on the water where they are to return. ▪ Size at release should enhance post-release survival and minimize any negative ecological interactions that may be due to differences from wild fish. ➢ Prevent the introduction, spread, or amplification of fish pathogens in accordance with the *Co-Managers Fish Disease Control Policy.* ➢ Fish management ▪ Pool fish so that any differences in rearing conditions will affect all families equally. ▪ Culling should be as random as possible. ▪ Limit the number of times fish must be moved during rearing.
Release of Fish	➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient proportion of the fish released such that stray rates and the proportion of project fish in the target population can be accurately estimated.

Issue	Guidelines
Management of Returning Adults	➢ Proportion of project fish spawning naturally with the target population: If a project meets all other guidelines, the proportion of hatchery fish *of this stock* on the spawning grounds of the target population should be small (less than about 15% of the total abundance). ➢ Control of straying to non-target populations: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population and/or to the hatchery, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically dissimilar populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species capture returning adults as an egg source or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks. ➢ The use of fish weirs or racks should be considered if necessary to control the proportion of natural spawners that are hatchery fish.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds, unless they are the most suitable stock for a restoration project or unless they are being used in an isolated harvest project. ➢ Return hatchery-spawned carcasses to local streams for nutrient supplementation following a written application to the co-managers and meeting fish health guidelines.

Table A.3. Guidelines for Isolated-Harvest Projects.

Issue	Guidelines
Population Status	➢ Not applicable, as long as harvest or hatchery operations do not have a significant negative impact on natural populations.
Scale of Project	➢ Total hatchery propagation should be based on meeting harvest objectives, legal agreements, or treaty obligations while keeping within genetic and ecological guidelines. ➢ Duration of project is unrestricted as long as guidelines are met.
Changing or Terminating the Project	➢ If the guidelines on limiting genetic and ecological risks to natural populations cannot be met, change or terminate the project.
Measures of Success	➢ Successful isolated-harvest projects will ▪ Produce fish for harvest; ▪ Limit genetic and ecological impacts to natural populations to acceptable levels.
Choice of Brood Stock	➢ Any brood stock that has the desired life history traits to make the project successful. Where possible, these should be from local stocks.
Collection of Brood Stock	➢ Brood stock must be obtained without significant risks to natural populations.
Brood Stock Spawning	➢ Matings should be designed to accomplish project objectives.
Rearing of Fish	➢ Use appropriate aquacultural practices to maximize survival at all life history stages in the hatchery environment and returns of fish to the fishery. ➢ Fish size at release should enhance post-release survival and minimize any negative ecological interactions with wild fish. ➢ Prevent the introduction, spread, or amplification of fish pathogens in accordance with the *Co-Managers Fish Disease Control Policy.*
Release of Fish	➢ Design release strategies to allow fish to return to the desired areas at the desired times while minimizing straying and harmful ecological interactions. Strategies may include ▪ Locating hatchery or release facility to limit ecological interactions and improve isolation; ▪ Using only on-station releases of fish; ▪ Using volitional releases. ➢ Mark a sufficient proportion of the fish such that stray rates can be measured accurately.

Issue	Guidelines
Management of Returning Adults	➢ Proportion of project fish intended for spawning in the wild: None. ➢ Control of straying to natural populations: Gene flow from project fish to native, natural populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically distinct populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than the proportion of target fish spawning in a non-target population. ➢ In facilities that rear several stocks of the same species and that capture the returning adults as an egg source or that have naturally spawning populations of the same species within the watershed, reliable marking methods should be used to identify and separate stocks.
Other Disposition of Fish	➢ Excess eggs, juveniles, or adults should not be transferred to other watersheds where this stock did not historically occur unless it is for another isolated harvest project or unless this is the most appropriate stock for a reintroduction project. ➢ Hatchery-spawned carcasses may be returned to local streams for nutrient supplementation where appropriate. Plantings of carcasses should be based on a written application to the co-managers and must meet fish health guidelines for carcass distributions.

Table A.4. Guidelines for Isolated-Recovery Projects.

These guidelines are primarily aimed at captive brood stock projects. Most other recovery projects are probably more appropriately treated under the 'integrated' category.

Issue	Guidelines
Population Status	➢ Population at very high risk of extinction.
Scale of Project	➢ Total production should be based on the number of fish needed to ▪ prevent extinction, ▪ adequately represent genetic variation for life history traits of the wild population, ▪ minimize genetic change during captivity, ▪ reestablish the fish in the wild. ➢ Duration should be a short as possible (ideally, 1-3 generations or less).
Changing or Terminating the Project	➢ If risk of immediate extinction lessens because causes of decline are being corrected, terminate or change to an integrated-recovery project.
Measures of Success	➢ Successful projects will ▪ Prevent extinction ▪ Maintain fish with minimal genetic change from the original source population; ▪ Reintroduce fish that are phenotypically similar to wild fish of the same age in development, morphology, physiological state, and behavior. ▪ Increase the number of fish reproducing successfully in the wild.
Choice of Brood Stock and collection	➢ Use as brood stock only fish from the population targeted for recovery. ➢ Collect as representative a sample from the population as possible and collect sufficient numbers of fish to meet minimal guidelines on maintaining a sufficiently large genetic effective population size.
Brood Stock Spawning	➢ Spawn all available adults ➢ Retrieve all possible eggs from mature females, either by multiple live spawning while minimizing stress to the fish or by careful attention to ripeness and handling. ➢ Use numbers and proportions of males and females and a mating strategy that will meet low-risk guidelines for maintaining the variance effective population size. If brood stock sizes must be very small due to low natural population abundance, use spawning protocols that will maximize genetic effective size, such as ▪ factorial matings ▪ use of cryopreserved sperm ▪ induced spawning ▪ fertilizing with milt from a second male ~ 60 seconds after initial fertilization ("backup male").

Issue	Guidelines
Brood Stock Spawning (cont.)	➢ Weigh benefits of using cryopreserving sperm or sperm extender against potential loss of viability, especially when the number of available eggs is very low.
Rearing of Fish	➢ Use rearing conditions that maximizing survival at all life history stages in the hatchery environment, while producing fish that are qualitatively similar to natural fish in size, morphology, behavior, physiological status, health and other ecological attributes that are important for fitness. Emphasize maximizing survival when threats to population abundance (extinction) are greatest; emphasize similarity to natural fish when preparing for reintroduction (see below). ➢ As much as possible, mimic wild rearing conditions (light, cover, substrate, flow, temperature, densities) for fish to be released in the wild. ➢ Facilities for freshwater rearing should have access to pathogen and predator free water. ➢ Transfer of fish to seawater for rearing or release should be done so as to not compromise the ability of the fish to adapt to seawater. ➢ Seawater-based rearing facilities should be able to withstand the effects of storms, harmful phytoplankton, predation, poaching, and disease.
Release of Fish	➢ Release fish at a life stage where probability of survival is greatest. ➢ Acclimate fish to water from locations in the watershed where they are intended to return. ➢ Design release strategies to integrate hatchery-reared fish with wild fish of the same life history stage, if any remain in the stream. ➢ When fish are likely to remain in the release area (for example, presmolts or residuals), disperse fish at several locations. ➢ Release fish to minimize stress caused by handling, transportation, or new surroundings. ➢ Minimize negative interactions with other species present in the watershed. ➢ Mark a sufficient proportion of the fish such that stray rates can be accurately estimated.
Management of Returning Adults	➢ <u>Proportion of project fish spawning naturally with the target population</u>: If the project meets all other guidelines and is estimated to provide a net benefit to the target population (see Part 2), there is no restriction on the proportion of hatchery fish *of this stock* on the spawning grounds during the reintroduction phase of the project. ➢ <u>2. Control of straying to non-target populations</u>: Case I: If the target population is native to the watershed and all other guidelines are met, straying should be controlled by ensuring that project fish home with high fidelity to the natural spawning grounds of the target population and/or to the hatchery, and that gene flow from project fish to non-target populations is not substantially greater than expected under natural conditions. Case II: If the target population is not native to the watershed, gene flow from project fish to non-target, native populations should be very low (e.g. less than ~1% of the effective population size of the non-target population, or approximately equal to the natural rate of straying between similarly genetically dissimilar populations - see Appendix B). In most cases, the rate of gene flow will probably be somewhat less than proportion of target fish spawning in a non-target population.

Issue	Guidelines
Other Disposition of Fish	➢ Where isolated recovery projects produce more fish than are needed for future brood stock or release into the wild, the extra fish will be culled randomly and disposed of in a manner that is agreeable to the co-managers and that does not jeopardize the project or other recovery projects.

APPENDIX B. MONITORING ACTIVITIES

This section summarizes monitoring associated with hatchery production. It is not intended to be a complete description of all the monitoring that provides important information for making decisions about hatcheries undertaken by the co-managers. The co-managers describe monitoring of the contribution of hatchery fish to different fisheries or the proportion the hatchery and wild fish escaping to spawning grounds, for example, in harvest resource management plans. In addition, individual hatchery programs may monitor additional aspects of fish culture, fish performance, and environmental quality that are not included here. Descriptions of these are available in HGMPs.

Marking, Release, and Sampling of Hatchery Fish

Kinds of Marks

The ability to distinguish hatchery fish from naturally produced fish is a prerequisite for monitoring hatchery fish once they leave the hatchery. The co-managers maintain extensive marking programs for hatchery fish. The programs rely on three main kinds of marks: adipose fin clips, coded-wire tags (CWT), and otolith marks. Clipping the adipose fin of juvenile salmon (sometimes called mass marking) provides a quick method of identifying whether a fish originated in a hatchery but provides no other information. Marking a fish with a coded-wire tag is more difficult and expensive but it also provides specific information about where, when, and under what conditions the fish was raised and released. Otolith marks provide hatchery and production group specific information but are more difficult to read and are less commonly used. There has been little formal effort to coordinate otolith marks or sampling among programs or species. Finally, at least one stock of hatchery fish in the Puget Sound—Tulalip fall chum salmon—has a genetic mark, which allows managers to monitor not only the presence of hatchery fish but also their progeny.

The CWT system provides most of the scientific monitoring data for hatchery coho salmon and Chinook salmon. The CWT system is an extensive, cooperative, international program. A selected sample of hatcheries from British Columbia, Washington, and Oregon applies CWTs to statistical sample of their fish (Figure B.1, Table B.1, B.2). Most CWT fish also have adipose fin clips to allow surveyors to identify whether a fish has a CWT that should be de-coded. A few programs have double index tags (DIT). This involves tagging paired groups of fish from a hatchery with CWT but one group has an adipose fin clip and the other does not. Data from CWT fish are collected during ocean fisheries, recreational fisheries, hatcheries, and spawning ground surveys and maintained in public databases by the Pacific States Marine Fisheries Commission.

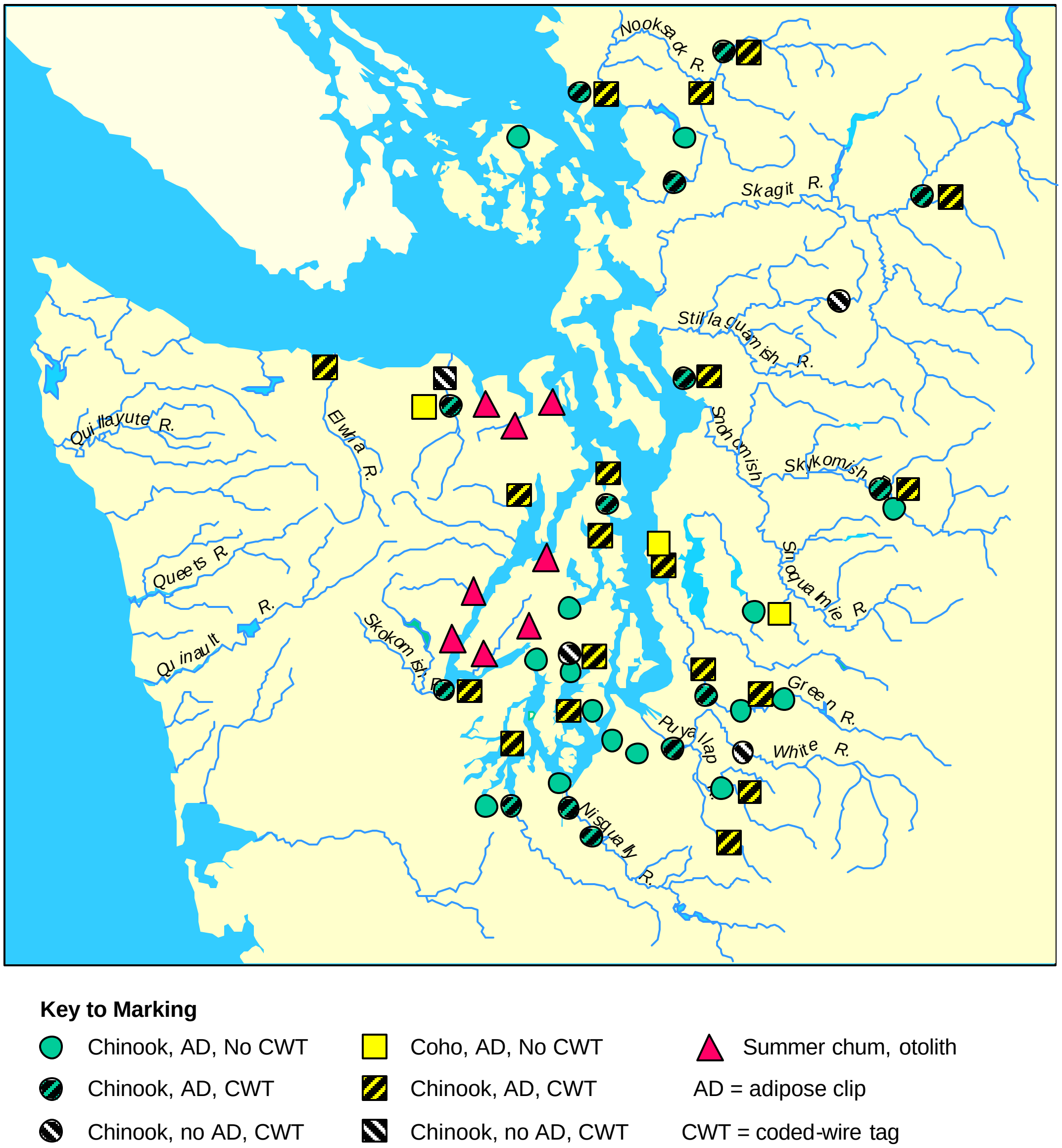

Figure 10. Locations of fish marking programs in the Puget Sound based on 2001 releases.

Coho salmon

Table 69. Coded-wire tag (CWT) and adipose (AD) marking and releases of 1999 brood-year coho salmon from Puget Sound hatcheries in 2001 (SFEC-RCWG 2003).

		CWT		No CWT		
Hatchery	Group	AD	No AD	AD	No AD	Total
Agate Pass Seapens	Suquamish Tribe, WDFW	50,000	0	250,000	0	300,000
Bernie Gobin	Tulalip Tribe	47,067	403	243,591	608,939	900,000
Clear Creek	Nisqually Tribe	0	0	0	0	0
Crisp Creek	Muckleshoot Tribe	45,582	1,100	143,748	4,570	195,000
Dungeness	WDFW	0	0	548,700	0	548,700
Elliot Bay Net Pens	Suquamish & Muckleshoot Tribes	50,000	0	400,000	0	450,000
Elwha	WDFW	0	0	0	294,400	294,400
Fox Island Net Pens	WDFW	0	1,154	59,525	296	60,975
George Adams	WDFW	49,403	51,637	388,838	4,114	493,992
Hurd Creek	WDFW	0	8,680	0	74	8,754
Issaquah	WDFW	0	0	505,600	0	505,600
Kalama Creek	Nisqually Tribe	0	0	0	0	0
Kendall Creek	WDFW	43,621	46,896	217,816	8,467	316,800
Keta Creek	Muckleshoot Tribe	0	0	0	559,625	559,625
Lower Elwha	Lower Elwha Tribe	150,447	63,482	22,141	258,540	494,610
Lummi Bay	Lummi Tribe	46,125	3,644	715,664	55,282	820,715
Marblemount	WDFW	109,551	45,514	95,886	949	251,900
Minter Creek	WDFW	20,064	60	1,341,391	27,810	1,389,325
Port Gamble Net Pens	Port Gamble S'kallam Tribe, WDFW	44,184	47,448	325,353	16,235	433,220
Quilcene Bay Net Pens	Skokomish Tribe, USFWS	40,000	40,000	0	120,000	200,000
Seattle Aquarium	WDFW	0	0	16,979	0	16,979
Skookum Creek	Lummi Tribe	44,224	4,628	641,957	66,566	757,375
Soos Creek	WDFW	43,799	50,354	456,885	50,518	601,556
South Sound Net Pens	WDFW	46,413	1,635	1,251,478	44,047	1,343,573
Upper Puyallup River	Puyallup Tribe	100,369	0	96,771	0	197,140
Voights Creek	WDFW	44,122	44,593	1,083,897	22,214	1,194,826
Wallace River	WDFW	47,762	43,430	62,141	2,012	155,345
Whatcom Creek	WDFW	0	0	0	0	0

Chinook Salmon

Table 70. Coded-wire tag (CWT) and adipose (AD) marking and releases of 2000 brood-year Chinook salmon from Puget Sound hatcheries in 2001 (SFEC-RCWG 2003).

		CWT		No CWT		
Hatchery	Group	AD	No AD	AD	No AD	Total
Bernie Gobin	Tulalip Tribe	162,137	3,141	24,863	1,229,859	1,420,000
Clear Creek*	Nisqually Tribe	169,143	176,207	2,068,077	294,881	2,708,308
Coulter Creek	WDFW	0	0	1,088,728	14,272	1,103,000
Diru Creek	Puyallup Tribe	233,487	3,767	4,144	2,755	244,153
Dungeness	WDFW	94,431	706,201	177,869	1,106,279	2,084,780
Elwha	WDFW	0	0	0	2,583,000	2,583,000
Garrison Springs	WDFW	0	0	619,236	27,149	646,385
George Adams*	WDFW	223,009	227,460	487	3,384,664	3,835,620
Glenwood Springs	WDFW	0	0	250,000	0	250,000
Gorst Creek	Suquamish Tribe	0	0	1,275,443	13,404	1,288,847
Grovers Creek*	Suquamish Tribe	203,754	206,563	25,211	229,427	664,955
Hoodsport	WDFW	0	0	0	3,059,892	3,059,892
Hupps Springs (White River)	WDFW	0	238,765	0	3,562	242,327
Issaquah	WDFW	0	0	2,053,605	141,168	2,194,773
Kalama Creek	Nisqually Tribe	83,178	3,655	471,237	9,529	567,599
Kendall Creek*	WDFW	197,364	199,511	1,636	1,248,789	1,647,300
Keta Creek	Muckleshoot Tribe	0		587,392	0	587,392
Lummi Bay	Lummi Tribe	167,171	4,003	801,414	18,663	991,251
Marblemount	WDFW	366,150	736	1,471	0	368,357
Marblemount (springs)	WDFW	268,460	541	1,078	0	270,079
McAllister Creek	WDFW	0	0	841,476	31,424	872,900
Minter Creek	WDFW	0	0	1,789,587	55,063	1,844,650
Percival Cove Net Pens	WDFW	0	0	591,127	22,673	613,800
Samish*	WDFW	146,129	151,312	3,225,739	219,097	3,742,277
Soos Creek*	WDFW	194,248	205,861	2,945,147	50,409	3,395,665
Tumwater Falls	WDFW	109,140	11,110	2,992,044	96,906	3,209,200
Voights Creek	WDFW	0	0	1,571,505	39,935	1,611,440
Wallace River*	WDFW	205,008	215,556	776,559	26,071	1,223,194
White River	Muckleshoot Tribe	0	253,592	0	26,121	279,713
Whitehorse	WDFW	0	192,789	0	0	192,789

Table 71. Coded-wire tag (CWT) and adipose (AD) marking and releases of 1999 brood-year Chinook salmon from Puget Sound hatcheries in 2001 (SFEC-RCWG 2003)

		CWT		NO CWT		
Hatchery	Group	AD	No AD	AD	No AD	Total
Bernie Gobin	Tulalip Tribe	37,861	282	494	143	38,780
Chambers Creek	WDFW	0	0	80,289	8,722	89,011
Fox Island Net Pens	WDFW	0	0	196,367	14,783	211,150
Gorst Creek	Suquamish Tribe	0	0	110,052	0	110,052
Hoodsport	WDFW	0	0	0	247,931	247,931
Hupps Springs (White River)	WDFW	0	83,742	0	6,595	90,337
Icy Creek	WDFW	0	0	241,300	0	241,300
Lakewood	WDFW	0	0	172,122	14,234	186,356
Marblemount*	WDFW	71,246	74,251	865	1,031	147,393
McAllister Creek	WDFW	0	0	122,005	7,995	130,000
Mukilteo Net Pens	WDFW	0	0	1,900	0	1,900
Samish	WDFW	0	0	78,235	5,448	83,683
Tumwater Falls	WDFW	67,926	1,965	107,034	3,075	180,000
Wallace River	WDFW	0	0	500,000	0	500,000
Whatcom Creek	WDFW	0	0	120,980	0	120,980
White River	Muckleshoot Tribe	0	82,204	0	7,735	89,939

Other Species

Nearly 100% of hatchery steelhead produced in western Washington are marked with adipose fin clips to support fishery regulations restricting harvest on naturally produced fish.

Sockeye salmon, chum salmon, and pink salmon are more difficult to mark because the life-history of these species usually requires releasing them from the hatchery as fry before they are large enough to insert CWT or remove fins. These fish can be marked during early development by altering water temperatures or water chemistry to leave a distinct pattern on the otoliths, a bony structure in the ear of fish. Using this mark effectively therefore requires the ability to manipulate water temperatures or chemistry and the ability to kill all fish that need to be sampled to determine whether they are of hatchery or natural origin.

Otolith marking is important for monitoring supplementation and reintroduction of summer chum salmon. The summer chum salmon marking program includes fish in Jimmycomelately Creek, Chimacum Creek, Big Beef Creek, Hamma Hamma River, Lilliwaup Creek, Salmon River, Tahuya River, and Union River (Figure B.1). Of the two sockeye salmon programs in the Puget Sound, all the sockeye salmon from the Cedar River Hatchery receive otolith marks. Sockeye salmon from the Baker Lake artificial spawning beaches do not have marks because they are reared in the gravel, although a small number of fish raised in raceways for experiments are marked. Chinook salmon hatchery programs that currently have marked fish include Dungeness River, Kendall Creek (spring race), Samish, Tulalip, and George Adams fish that are used in the Hamma Hamma River. Coho salmon hatchery programs that currently have otolith marked fish include Nooksack River and Snow Creek.

Developing and Maintaining Genetic Baselines

Genetic monitoring and evaluation are important elements of the oversight and stewardship responsibilities of the comanagers. Since the inception of the WDFW Genetics Laboratory in 1985, the comanagers have implemented an ambitious field sampling program to obtain the necessary tissue samples (and associated biological data) and conducted laboratory-based genetic analyses of Pacific salmon and trout. The comanagers have now collected over 26,000samples for allozyme analysis and over 40,000 samples for DNA analysis (Table 72).

In order to federal ESA needs for relevant biological data upon which to evaluate alternative approaches, actions, and ESU status and compliance, the comanagers will continue to collect biological samples of both natural and hatchery spawning population of Pacific salmon and trout throughout Puget Sound. It is our intent to collect genetic samples (almost entirely non-lethal tissue samples for DNA analysis) from a total of approximately 200-300 fish from each of the natural-spawning and hatchery-produced populations of Pacific salmon, steelhead, and resident trout in Puget Sound over the coming five years.

Hatchery Brood Stock Selection

Each hatchery program monitors compliance with brood stock selection guidelines. Appropriate sources and methods for collecting brood stock are described in HGMPs and WDFW's Hatchery Operation Plans and Performance Summaries. During spawning, hatchery personnel monitor the number, sex, and developmental state of all brood stock.

Fish Culture and Health

Each hatchery program monitors standard fish culture variables, including environmental characteristics (e.g., water temperature and flows) and number of eggs collected, fertilization success, feeding rates, growth and survival to different developmental stages, number of fish marked, locations and dates of fish transfers between rearing locations, fish health, and number and size of fish released.

Both the state and tribes conduct rigorous fish health monitoring. At spawning, WDFW and tribal fish pathologists examine a minimum of 60 ovarian fluid samples and 60 kidney and spleen samples for viral pathogens from each group and stock of fish. During rearing, the pathologists examine a representative sample of each stock of fish monthly, before transfer, and before release and the findings are recorded on WDFW Form FH01 or in the Fish Health Database at the Northwest Indian Fisheries Commission (NWIFC). Pathologists report and control fishpathogens following the Co-managers' Fish Disease Policy. All hatcheries monitor compliance with fish disease prevention and therapeutic measures, such as disinfection of eggs with iodophor, disinfection of nets, boots, tanks, and rain gear, administering antibiotics, and control of parasites.

Table 72 . Puget Sound genetic baseline collections and data for Pacific salmon, steelhead, and resident trout (1985-2003).

		Allozyme Data				DNA Data				Archived for DNA Analysis			
Species	Origin	Collections	Populations	Years	Total Fish	Collections	Populations	Years	Total Fish	Collections	Populations	Years	Total Fish
Chinook salmon	N	60	28	16	3773	17	4	7	964	77	27	18	5179
	H	45	13	12	4182	9	7	2	967	53	16	17	4980
Coho salmon	N	-	-	-	-	2	1	2	180	47	18	9	6696
	H	-	-	-	-	7	3	3	610	24	12	10	2384
Chum salmon	N	122	63	18	9395	14	12	8	897	161	65	19	12773
	H	21	10	11	2012	4	4	3	249	28	10	13	2860
Pink	N	63	27	12	4655	2	2	1	200	34	14	8	2794
	H	7	6		450	1	1	2	956	4	2	2	1006
Sockeye	N	-	-	-	-	4	4	1	253	8	4	3	651
	H	-	-	-	-	-	-	-	-	-	-	-	-
Steelhead	N	26	25	4	1543	-	-	-	-	18	10	7	751
	H	3	3	2	150	-	-	-	-	4	4	3	294
Resident	N	6	2	5	266	2	2	2	162	3	3	3	202
O. mykiss	H	5	5	1	521	4	4	3	296	4	4	6	296

Screening and Passage

Hatchery intakes deliver water by either gravity or pumped induction to specific hatchery ponds or to a water collection facility. Intakes are screened to prevent wood debris, river sediments, juvenile fish, amphibians and aquatic invertebrates from entering the system. Tribal hatchery programs assess screening as part of routine maintenance. WDFW has assessed hatchery screening on a number of occasions (Shelfer, pers. comm.; Mills 2001) and is in the process of reassessing each facility in Puget Sound relative to current guidelines and criteria. Screening criteria and guidelines under which facilities may be assessed include: 1) WDFW Screening Requirements for Water Diversions (no date); RCW 77.16.220, RCW 75.20.040, RCW 75.20.061; 2) Fish Protection Screen Guidelines for Washington State (WDFW 2001); 3) NMFS Juvenile Fish Screen Criteria (1995) and 4) NMFS Juvenile Fish Screen Criteria for Pump Intakes (1996).

Hatchery facilities may include weirs, traps, or channels to assist in the collection of returning adults for hatchery broodstock. Passage criteria and guidelines are available in several locations, including: 1) WAC 220-110-070, RCW 77.55.060, RCW 77.55.070; 2) Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (WDFW 2000); and 3) Fishway Guidelines for Washington State (WDFW 2000). Fish passage facilities were most recently reviewed by Mills (2001); WDFW is in the process of reassessing each facility in Puget Sound relative to current guidelines and criteria.

Pollution Abatement

Hatchery programs monitor water quality at their facilities to identify 1) when detrimental environmental changes in the watershed from logging, road building, or urbanization hatchery might be decreasing water quality to a point where it impacts fish culture, and 2) when discharges from hatchery might be negatively impacting water quality and require changes in fish culture. WDFW hatchery programs at facilities producing more than 20,000 pounds of fish annually monitor water quality variables to meet the requirements of the National Pollution Discharge Elimination Permit System (NPDES), which is administered by Washington Department of Ecology. Tribal programs located on reservations also monitor water quality. Tribes are currently working with the Environmental Protection Agency (EPA) to develop a starndardized process for monitoring and reporting. Variables that are usually monitored as part of the NPDES system include total suspended solids, settleable solids, upstream and downstream temperatures, upstream and downstream dissolved oxygen, water temperatures in the hatchery, and dissolved oxygen in the hatchery. Specific performance standards for WDFW hatchery programs are described in WDFW's Hatchery Operation Plans and Performance Summaries.

APPENDIX C: RESEARCH

Tribal Hatchery Research Programs

The Tribes have been using recently available funds for hatchery reform to identify and fund research to improve hatchery practices. Each year, the Northwest Indian Fisheries Commission (NWIFC) solicits proposals for research from member tribes. NWIFC biometricians, salmon ecologist, and fish geneticist work with the tribes to develop rigorous research proposals. The projects are presented, evaluated, and ranked by merit by tribal enhancement biologists and independent NWIFC scientists during a two-day workshop. Ranking is based on the description of methods (20%), assumptions (10%), costs (15%), and relevance to hatchery reform (55%). A Hatchery Reform Steering Committee evaluates the process for soliciting, improving, and selecting submitted projects for tribal hatchery reform funding annually and suggests changes.

During 2002-2003, 24 tribal projects focused on improving hatchery practices and 10 projects to improve hatchery tribal facilities received funding though the competitive ranking process in 2002-2003. Most projects focused on Chinook salmon (*Oncorhynchus tshawytscha*), which is listed under the Endangered Species Act (Figure C.1). This reflected the higher priority given to projects associated with salmon recovery in the project ranking process and the importance of this species to the tribes rather than the relative need for hatchery reform for this species. The largest proportion of projects to improve hatchery practices focused on critical gaps in knowledge for choosing and modifying rearing-and-release strategies and evaluating potential interactions of hatchery and wild fish.

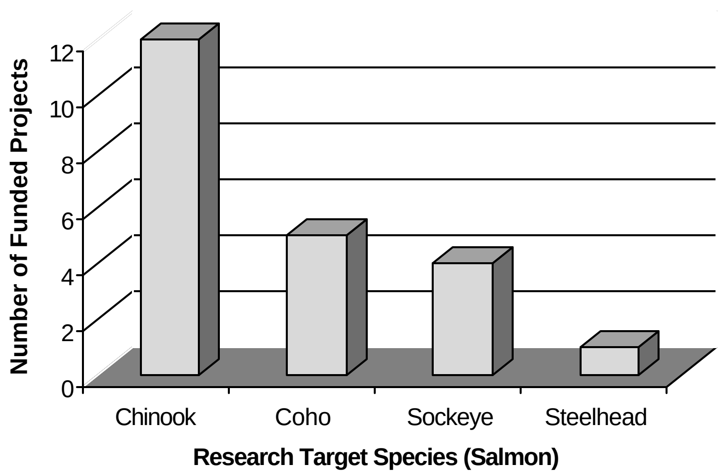

Figure 11. Number of tribal hatchery-reform research projects funded by species for 2002-2003.

Table 73. Hatchery-reform implementation projects for western Washington Treaty Tribes (2001).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	$54,716.00	$54,716.00
1-2	Stillaguamish	Determine if there have been genetic and morphological changes in North Fork Stillaguamish River summer Chinook	$49,355.00	$104,071.00
1-3	Lower Elwha	Lower Elwha enriched rearing environment study	$76,833.61	$180,904.61
1-4	Makah	Lake Ozette salmon out-migration monitoring project	$59,081.00	$239,985.61
1-5	Makah	Acoustic and radio telemetry of adult Lake Ozette sockeye, phase II	$40,000.00	$279,985.61
1-6	Stillaguamish	Smolt investigations on the mainstem Stillaguamish River	$50,213.00	$330,198.61
1-7	Puyallup	Puyallup Tribe's Chinook evaluation of Diru Creek	$16,461.58	$346,660.19
1-8	Quinault	Evaluation of Quinault hatchery steelhead smolt release strategies	$69,719.01	$416,379.20
1-9	Lummi	Lummi Bay Chinook tagging study	$28,121.00	$444,500.20
1-10	Nisqually	Chiller system for incubation water	$89,600.00	$534,100.20
1-11	Suquamish	Gorst Creek fall Chinook rearing ponds mass marking and hatchery/wild interactions monitoring and evaluation study	$89,992.00	$624,092.20
1-12	Lummi	Co-occurrence of hatchery and natural Chinook and coho in Nooksack near-shore habitats	$39,259.58	$663,351.78
		Total	**$663,351.78**	

Table 74. Hatchery-reform implementation projects for western Washington Treaty Tribes (2002).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Lower Elwha	Lower Elwha Enriched Rearing Environment Study	48,388.26	$48,388.26
1-2	Makah	Umbrella Creek Resistance Board Weir & Adult Trap Operation	17,683.00	$66,071.26
1-3	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	57,770.00	$123,841.26
1-4	Makah	Lake Ozette Sockeye Salmon Out-migration Monitoring Project	16,390.00	$140,231.26
1-5	Nisqually	Estimating Hatchery & Natural Returns of Chinook by Age to the Nisqually River	31,893.00	$172,124.26
1-6	Stillaguamish	Smolt Outmigration Study on the Stillaguamish River	47,810.00	$219,934.26
1-7	Makah	Lake Ozette Sockeye Computer-Enhanced Run Size Monitoring	24,503.00	$244,437.26
1-8	Tulalip	Survival Rate Comparison of Summer & Fall Chinook Broodstock at Tulalip Hatchery	31,653.00	$276,090.26
1-9	Nisqually	Juvenile Salmon Utilization of the Nisqually River Estuary	9,661.00	$285,751.26
1-10	Puyallup	Puyallup Tribe's Chinook Evaluation for Diru Creek	17,880.26	
1-11	Squaxin Island	Examination of Relative Return Rates & Straying of Coho Based on Broodstock & Intermediate Rearing Locations	61,200.00	
1-12	Suquamish	Increasing Post-Release Survival of Chinook Using Semi-Natural Rearing Habitat at Gorst Creek Hatchery	27,054.00	$312,805.26
1-13	Squaxin Island	Acoustic Monitoring of Tagged Juvenile Coho in South Puget Sound	49,245.39	$362,050.65
1-14	Makah	Genetic Characterization of Lake Ozette Sockeye Salmon	40,064.00	$402,114.65
		Total	$481,194.91	

Table 75. Hatchery-reform implementation projects for western Washington Treaty Tribes (2003).

Contract	Sponsor	Project Title	Cost	Cumulative Cost
1-1	Tulalip	Monitoring the contribution of Tulalip hatchery Chinook salmon to terminal fisheries and local natural spawning	$53,844.00	$53,844.00
1-2	Puyallup	White River Spring Chinook Broodstock Identification and Hybridization Study	$38,709.00	$92,553.00
1-3	Lower Elwha	Lower Elwha Enriched Rearing Environment Study	$48,388.26	$140,941.26
1-4	Tulalip	Survival Rate Comparisons of Summer & Fall Chinook Broodstock at Tulalip Hatchery	$33,875.00	$174,816.26
1-5	Makah	Umbrella Creek Sockeye Broodstock Capture & Adult Escapement Monitoring	$27,004.00	$201,820.26
1-6	Makah	Lake Ozette Sockeye Salmon Smolt Out-Migration Monitoring Project	$12,959.00	$214,779.26
1-7	Stillaguamish	Characterization of the Hatchery & Wild Chinook Smolt Outmigration on the Stillaguamish River	$69,261.00	$284,040.26
1-8	Quinault	Evaluation of Supplemental Coho Smolt Survival	$23,898.00	$307,938.26
1-9	Makah	Hoko River Chinook Salmon Smolt Out-Migration Monitoring Project	$19,308.00	$327,246.26
1-10	Nisqually	Juvenile Salmon Utilization of the Nisqually River Estuary	$40,460.00	$367,706.26
		Total	$367,706.26	

WDFW Hatchery Research Programs

WDFW conducts extensive research on hatchery programs throughout the state of Washington that are funded by state, federal, and local sources. Research expected to be conducted during 2004 is summarized in Table 76 relative to four primary categories: 1) genetics, 2) ecological interactions, 3) program performance, and 4) population structure of hatchery and natural populations.

Two recent appropriations have significantly enhanced the ability of WDFW to address critical questions related to the operation of artificial production programs: 1) a biennial appropriation of 1.0 million from the state legislature for implementation of HSRG recommendations; and 2) an annual federal appropriation of approximately 1.0 million for support of the HSRG process. WDFW has scored and prioritized potential research projects relative to six criteria: 1) consistency with HSRG recommendation; 2) required by HGMP or compliance with state or federal regulations; 3) status of affected natural populations; 4) opportunities for cost sharing; and 5) feasibility.

Table 76. Hatchery-reform implementation projects for WDFW in 2004.

Question	Species and/or Locations
1.0 Genetics. What are the magnitude of genetic effects of hatchery programs on wild salmonid populations.	
1.1 Inbreeding Depression. What is the magnitude of the effect in wild salmonid populations of inbreeding depression associated with hatchery programs?	No current research.
1.2 Outbreeding Depression. What is the magnitude of the effect in wild salmonid populations of outbreeding depression associated with hatchery programs?	No current research.
1.3 Domestication. What is the magnitude of the effect in wild salmonid populations of domestication associated with hatchery programs?	Deschutes River. Evaluate reproductive success and fitness maintenance of hatchery origin chinook spawning naturally in the Deschutes River. Minter Creek. Evaluate the reproductive success, fitness maintenance of hatchery and wild origin coho spawning in naturally in Minter Creek. Snow Creek. Evaluate the effectiveness of alternative artificial production strategies for restoring Snow Creek coho. Kalama River. a) Evaluate the survival from emergence to adult return of wild origin summer steelhead spawning in the Kalama River versus wild fish spawned and reared in the Kalama Falls Hatchery; and b) evaluate the survival from release to adult of hatchery (Chambers Creek origin) and wild (Kalaman River) origin fish reared at Kalama
	Yakima River. a) Monitor the reproductive behavior of hatchery and wild origin spawners in a spawning channel and evaluate the reproductive success of hatchery, wild, and hatchery x wild crosses; b) compare the survival and fecundity of adults returning from conventional and semi-natural rearing treatments; and c) measure genetic changes caused by adaptation to the hatchery environment. Tucannon River. Evaluate the effects of supplementation on wild stocks of steelhead and chinook. Wenatchee River. Evaluate the effects of supplementation on wild stocks of steelhead, chinook, and sockeye. Methow River. Evaluate the effects of supplementation on wild stocks of steelhead, chinook, and sockeye.

Table 76. continued.

Question	Species and/or Locations
2.0 Ecological. What are the magnitude of the ecological effects of hatchery programs on wild salmonid populations?	
2.1 Predation. What is the magnitude of predation mortality on wild salmonid populations resulting from the presence of fish of hatchery origin?	
2.1.1 Direct Predation. What is the rate of predation of fish released from hatcheries on natural populations of salmonids.	Deschutes River. Estimate the consumption rate of chinook by steelhead and the percentage of the total chinook population consumed by steelhead. Green River. Estimate the consumption rate of chinook by coho, steelhead, and yearling chinook.
2.1.2 Indirect Predation. How are predation losses of wild salmonids affected by the presence of fish of hatchery origin.	Lake Washington. Evaluate the effects of varying numbers of hatchery and natural origin sockeye smolts on survival rates through the Lake Washington basin.
2.2 Competition. What is the magnitude of the effect of competitive pressures on wild salmonid populations resulting from the presence of hatchery fish?	
2.2.1 Competition - Freshwater Rearing.	No current research.
2.2.2 Competition - Freshwater Migration.	No current research.
2.2.3 Competition - Estuaries and Puget Sound.	No current research.
2.2.4 Competition - Ocean.	No current research.
2.2.5 Competition - Adult Spawning.	Cedar River. Evaluate the effects of the number of sockeye spawners on the survival of chinook from egg deposition to lake entry.

Table 76. continued.

Question	Species and/or Locations
2.3 Behavioral Anomalies. What is the magnitude of the effect on wild salmonid populations of behaviorial anomalies (e.g., "Pied Piper"effect) resulting from the presence of hatchery fish?	No current research.
2.4 Disease. What is the magnitude of the effect on wild salmonid populations of disease related to hatchery programs?	
2.4.1 Disease - Direct. What is the magnitude of the effect on wild salmonid populations of disease transmitted from fish of hatchery origin?	No current research.
2.4.2 Disease - Indirect. What is the magnitude of the effect on wild salmonid populations of disease resulting from indirectly from the presence of hatchery origin fish (e.g., disease rate inflated because of agonistic interactions)?	No current research.
2.5 Nutrient Dynamics. What is the magnitude of the effect on wild salmonid populations of increased nutrient levels resulting from the carcasses of hatchery fish that spawned in natural areas?	No current research.

Table 76. continued.

Question	Species and/or Locations
3.0 Program Performance. What is the survival rate of fish released from the hatchery? What is the percentage of natural escapement comprised of fish of hatchery origin? How can the performance of a program be improved?	Marking and tagging. See individual program descriptions. Escapement sampling and analysis. See monitoring section. Improved program performance. a) Evaluate the effect of dirt ponds on survival of steelhead at Marblemout Hatchery. b) Evaluate the effect of a low phosphorous diet on survival of coho at Issaquah Hatchery. c) Evaluate the survival benefits obtained from sorting fish to achieve a target size at release for Wallave Hatchery coho, George Adams Hatchery coho, Naselle Hatchery coho, Kalama Fall Hatchery chinook, Washougal Hatchery chinook. d) Evaluate the improvements in survival associated with increased pigmentation resulting from feeding coho at Soos Creek Hatchery with astaxanthin. e) Evaluate survival benefits of NATURES rearing of coho at Soos Creek Hatchery. f) Evaluate survival benefits of directional feeders for coho in SPS net pens. g) Evaluate relative survival of small and large coho at Marblemeount Hatchery. h) Compare genetics and life history characteristics among South Sound, Skykomish, and Minter Creek Hatchery.
	i) Evaluate rate of straying of using local (Minter Creek) and nonlocal (Skykomish) coho in South Sound net pens. j) Compare rates of straying between in-region and out-of-region incubation and rearing.
4.0 Population Structure. What is the structure of the natural populations that the hatchery program might affect?	Genetic sampling and analysis. See monitoring section.

APPENDIX D: RISK ASSESSMENT MODELING PROJECT

Overview

What Is It?

The goal of this project is to develop a risk assessment tool for hatcheries that is consistent, transparent, and scientifically defensible. The focus is on biological risks to natural production, including risk to hatchery fish that are part of a conservation strategy for natural production. Risk is the set of outcomes associated with a hazard (source of loss) that have different consequences and probabilities of occurring.

Hatcheries pose four general kinds of hazards to natural populations—genetic, ecological, demographic, and facility—with different components (Figure 1). Our objective is to develop a separate assessment tool (or module), such as a causal probabilistic network (Figure 2), for each of these components that quantifies as much as possible the risks associated with each under different conditions.

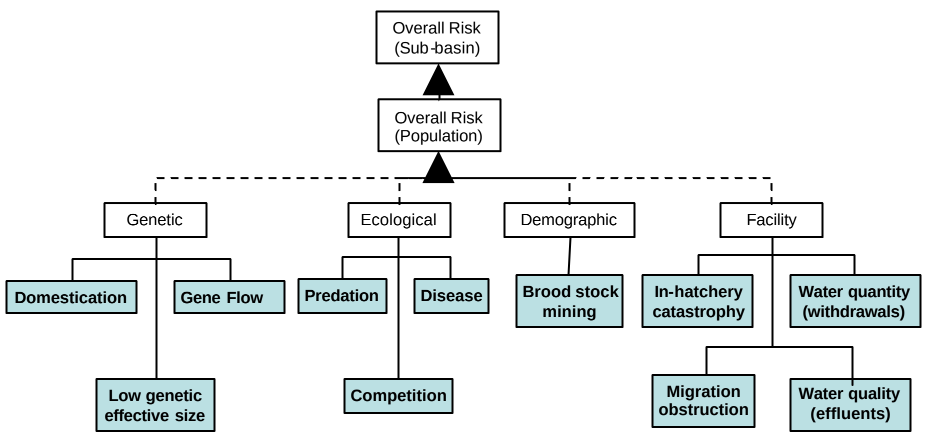

Figure 12. One possible organization of hatchery hazards. Shaded boxes are potential risk modules. Dotted lines show the roll-up of risks from all hazards to an overall risk for the population or sub-basin.

The consequences of these hazards can be measured in differentways, such as effects on abundance, fitness, or diversity. Ideally, we want to rollup the risks of each of these (i.e. take into account the interactions between the hazards) to an overall risk to the population or sub-basin, but developing this part of the tool may not be possible within the time-frame of this project.

Who Wants The Tool?

Western Washington treaty tribes, state, and federal agencies involved in managing hatcheries in the Columbia River and western Washington want an objective, transparent, rigorous tool for hatchery reform. The project was solicited by the Northwest Power Planning Council and is funded by Bonneville Power Administration.

Who Is Involved?

An important objective of this project is to represent the best available knowledge on these risks by including broad scientific participation. We have four key groups of participants. They are not mutually exclusive.

- *Principal Investigators*—Craig Busack, Ken Currens, Todd Pearsons, and Lars Mobrand are the principal investigators (PIs). They will do the bulk of the model development.
- *Advisory Group*—The advisory group consists of 10-12 scientists with 3-4 experts in each of the major kinds of hazards. Their role is to help the PIs identify the appropriate risk categories and sources of the risk the PIs wish to use (such as Figure 1), describe as influence diagrams or conceptual models the major factors influencing risk for each hazard, identify sources in the scientific literature of theoretical models that might be used, help with selection of the expert panel, and review the risk modules. Most of their participation will occur during three 2-day workshops.
- *Decision Theorists*—Two or three experts in decision theory, causal probabilistic networks, and expert elicitation help review the overall approach of the project.
- *Expert Panel*—This group includes 25-30 experts, including some members of the Advisory Group, who will be a source of expert knowledge on risk parameters when the scientific literature is inadequate. Expert elicitation will use the Internet.

When Does It Start?

The project starts in January 2004. The advisory group meets with the principal investigators in February and again in April and will receive regular updates on the project. Survey of the expert panel occurs during the summer. The advisory group meets again in September to review the final modules and report.

How Long Will It Take?

The project will completed by November 2004.

Whom Do I Contact for More Information?

Craig Busack
Washington Department of Fish and Wildlife
(360) 902-2765
busaccsb@dfw.wa.gov

Ken Currens
Northwest Indian Fisheries Commission
(360) 438-1181 ext. 374
kcurrens@nwifc.org

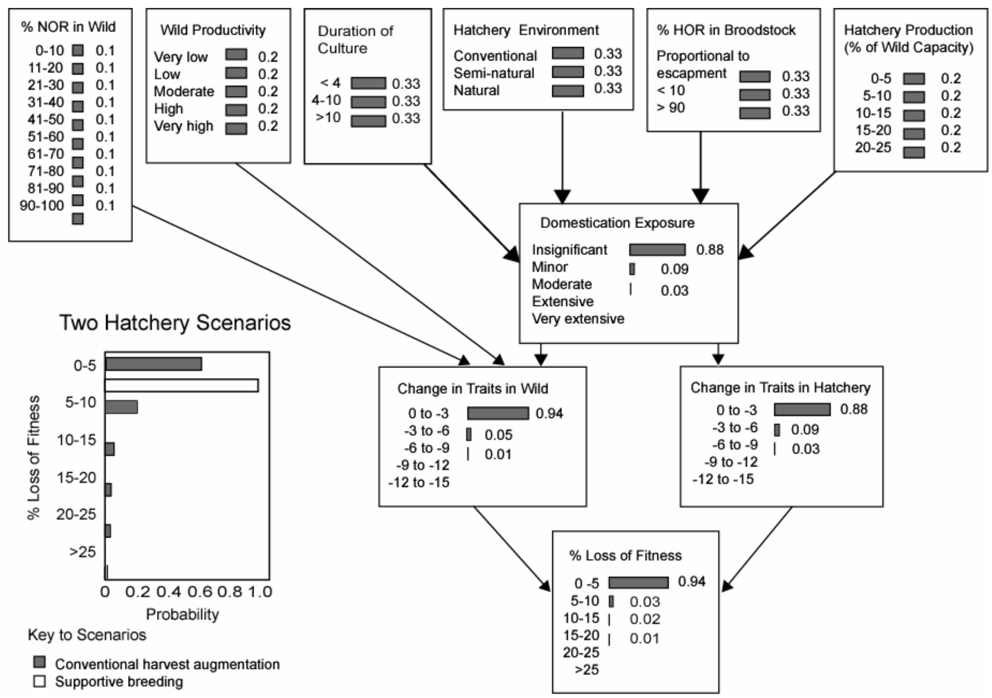

Figure 13. A causal probabilistic network for loss of fitness from domestication and risk assessment results from two hatchery scenarios (inset). The causal probabilistic network links different states of input variables (top row), dependent population variables, and risk outcomes through tables of probabilities developed from simulations, data, and expert knowledge. The histograms in the network show the initial probabilities before assessment. Inset histogram (lower left) shows probabilities for loss of fitness after assessment. The conventional harvest augmentation scenario assumed proportion of natural-origin recruits (% NORs) spawning in the wild was 41-50%; productivity in the wild was moderate; the program has been operating for 4-10 generations; the conventional hatchery environment was almost entirely artificial; more than 90% of brood stock was of hatchery origin (% HORs); and hatchery production was more than 20% of the stream's capacity. The supportive breeding scenario assumed the proportion of NORs spawning in the wild was 41-50%; wild productivity was low; the program has been going for less than 4 generations; hatchery environment was semi-natural; less than 10% of the brood stock was hatchery origin; and hatchery production was more than 20% of the stream's capacity.